EXPRESS MAIL LABEL NO. EV 710327528 US

PATENT APPLICATION
Docket No. 16096.6

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of		)
	Khemani, et al.	)
Serial No.:	10/087,718	) Art Unit) 1711
Filed:	March 1, 2002	)
Conf. No.:	7476	)
For:	BIODEGRADABLE FILMS AND SHEETS SUITABLE FOR USE AS COATINGS, WRAPS AND PACKAGING	)
Examiner:	Ana L. Woodward	)
Customer No.:	022913	)

DECLARATION OF SIMON K. HODSON

UNDER 37 C.F.R. § 1.131

Mail Stop AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Simon K. Hodson, hereby declare as follows:

1. I am one of the co-inventors of the subject matter disclosed and claimed in the above-identified application ("Subject Application"), and I am personally knowledgeable of the facts stated herein.

2. Kishan Khemani and Harald Schmidt are the other co-inventors of the subject matter disclosed and claimed in the Subject Application.

3. The subject matter claimed in the Subject Application is the result of a joint effort between me, Mr. Khemani and Mr. Schmidt.

4. The Subject Application is assigned to bio-tec Biologische Naturverpackungen GmbH & Co., KG. ("Biotec"), which is located at Werner-Heinsenberg-Sr. 32, Emmerich, Germany 46446.

5. Mr. Khemani and myself were employees of E. Khashoggi Industries, LLC ("EKI"), and Mr. Schmidt was an employee of Biotec, at the time of the invention.

6. Embodiments of biodegradable food wraps comprising one or more biodegradable polymers and inorganic particulate fillers were conceived and reduced to practice at least as early as July 2, 2000, as evidenced by a copy of an electronic mail communication attached hereto as Exhibit A from Mr. Khemani to me ("July 2, 2000 e-mail").

7. The July 2, 2000 email indicates that Mr. Khemani had, at least as early as July 2, 2000, produced and tested blown films or sheets from various blends having the general formula:

Biomax 6926	60-70%
Ecoflex F	5-20%
Biomax (unknown grade)	10-20%
Talc	5-10%
TiO_2	5-10%

8. Biomax and Ecoflex are biodegradable polymers manufactured by DuPont and BASF, respectively; talc and TiO_2 (titanium dioxide) are inorganic particulate fillers added to give the food wraps the look, feel and dead-fold of paper rather than plastic.

9. The July 2, 2000 email indicates that biodegradable blends within the general formula of ¶ 7 had already been made at "Gemini" (*i.e.*, using a Gemini blowing apparatus, discussed below) and that Mr. Khemani was planning to "finish these tests" by which he "expect[ed] to have a recommended single formula" within 3-4 weeks, thus evidencing that food wraps within the scope of the invention had been manufactured at least as early as July 2, 2000.

10. A patent application filed shortly thereafter on August 23, 2000 as U.S. application Serial No. 09/648,471 ("'471 Application), covering a blend of biodegradable polymers and fillers, as well as biodegradable sheets and films, suitable for use in making food wraps similar or identical to blends and wraps disclosed and claimed in the Subject Application.

11. The '471 Application issued as U.S. Patent No. 6,573,340 ("'340 Patent") on June 3, 2003 (after the filing date of the Subject Application) and currently names the same inventors as the Subject Application, as indicated by a Certificate of Correction issued by the USPTO on

November 11, 2003. A copy of the '340 patent (including the Certificate of Correction) is attached hereto as Exhibit B.

12. Both the '471 Application and the Subject Application were initially assigned to EKI when initially filed and later simultaneously re-assigned to Biotec.

13. Although the Subject Application does not claim priority to the '471 Application, the '471 Application constitutes a constructive reduction to practice regarding all that is disclosed therein by the inventors of the Subject Application.

14. The '471 Application disclosed, among other things, the use of inorganic particulate fillers having a particle size up to about 2 mm and a concentration up to 90% by volume or 95% by weight in order to impart desired properties, including dead-fold (*i.e.*, the tendency of a food wrap to retain a fold or crease rather than spontaneously unfolding like many plastic sheets or films). '340 Patent, col. 14, lines 40-43; col. 15, lines 50-60; col. 16, lines 13-17.

15. Examples 4-12 of the '471 Application included a biodegradable polymer and various quantities of one or more inorganic particulate fillers, with Examples 6-12 expressly stating that the extruded films made therein had excellent dead-fold properties, which resulted at least in part from the inclusion of the particulate fillers, thus being especially suitable for use as food wraps. *Id.* at col. 21, lines 63-64; col. 22, lines 17, 36-38, 59; col. 23, lines 3-5, 25-31, 44-45, 48-49.

16. The films of Examples 4-12 were blown using either a Gemini film blowing extruder (at the Gemini plant referred to in the July 2, 2000 email and ¶ 7 above) or a proprietary extrusion/film blowing apparatus owned by Biotec. *Id.* at col. 21, lines 66-67; col. 22, lines 26-29; col. 23, lines 1-3, 39-42.

17. I personally inspected one or more of these films and found that the film blowing apparatus employed in Examples 4-12 stretched the films while in a softened state, yielding films having cavitation and therefore especially suitable as food wraps (*e.g.*, the cavitation produced by the blowing process provided the food wraps with good breathability, which assisted in reducing moisture condensation when wrapping hot, steamy food items).

18. From the inspection of one or more of these films I found that the stretching of the films in Examples 4-12 yielded films in which in a portion of the filler particles protruded from

the surface, thus yielding films having a roughened, paper-like feel rather than the smooth feel of plastic sheets, making them suitable for use as food wraps.

19. The '471 Application also taught the concept of texturing a film or sheet using knurled or other embossing-type rollers in order to improve its "bulk hand feel" and make it seem more like paper than plastic, thus constituting a constructive reduction to practice as of August 23, 2000 of "texturing" as claimed in the Subject Application. *Id.* at col. 4, line 66 – col. 5, line 9.

20. After working to manufacture and test the extruded films referred to in the July 2, 2000 e-mail and the '471 Application filed August 23, 2000, we (the inventors) continued to diligently prepare and test various biodegradable polymer and filler blends on an ongoing basis leading up to the filing of the Subject Application in order to optimize sheets and films for use as food wraps, as evidenced by a series of email communications dated between February 25, 2001 and October 16, 2001, copies of which are attached hereto as Exhibits C-G.

21. In the e-mail dated February 25, 2001 (Exh. C), reference is made to "paper-like tissue, 30 micron", which refers to polymer films made according to the July 2, 2000 email and the '471 Application that included particulate fillers, that were stretched using the blowing apparatus referred to in the ''471 Application and the July 2, 2000 email, and that had filler particles that protruded from the surface of the film in order to create a roughened and/or porous surface that gave the film the look and feel of paper-like tissue.

22. The e-mail dated April 6, 2001 (Exh. D) includes extensive economic modeling of the wrap technology, which further evidences work diligently performed leading up to the filing of the Subject Application.

23. The e-mail dated June 22, 2001 (Exh. E) discusses "previous wrap trials" that were performed on actual filled polymer sheets, which is further evidence of the extent to which the wrap technology had been diligently developed and tested leading up to the filing of the Subject Application.

24. The e-mail dated August 31, 2001 (Exh. F) provides extensive test results relating to microwaveability, grease resistance, burger test, puncture resistance, dead fold of 100%, and time in motion for wraps developed as early as the July 2, 2000 email and/or the '471 Application. This communication shows that, although the polymer films breathed less than

paper wraps, they did breath nevertheless, which is evidence of the fact that they included significant cavitation as a result of stretching during film blowing, as discussed above.

25. The e-mail dated October 16, 2001 (Exh. G) refers to a filled polymer film wrap that included 35% filler, further evidencing diligence leading up to the filing of the Subject Application.

26. Shortly thereafter, the Subject Application was drafted and later filed on March 1, 2002.

27. As evidenced by the documentary evidence attached hereto, I declare that the subject matter of at least claims 1-13 and 15-35 was invented prior to December 7, 2000, and at least as early as the filing date of the '471 Application on August 23, 2000 and/or the July 2, 2000 email.

28. Moreover, as inventor of the Subject Application I am familiar with thermoplastic starch made without plasticizers (*i.e.*, "free of plasticizers"), which differs significantly from "thermoplastic starch" made using plasticizers, such as is taught in U.S. Patent No. 6,069,809 to Lorcks et al.

29. Lorcks et al. teaches that the "thermoplastic starch" disclosed therein is made according to PCT/WO90/05161, which corresponds to U.S. Patent No. 5,362,777, and includes a substantial quantity of a plasticizer such as glycerin, typically 10%-40% by combined weight of the starch and plasticizer. Lorcks et al., col. 1, line 62 – col. 2, line 6.

30. U.S. Patent No. 5,362,777 to Tomka is also assigned to Biotec and discloses and claims a "thermoplastically processable starch" ("TPS") composition that is "substantially water free" and a method of manufacturing such composition. Tomka, col. 13, line 2; col. 14, line 40.

31. Tomka teaches that water (*e.g.*, the natural water content of starch) can be replaced with one or more plasticizers such as glycerin to lower the melting temperature of starch to below its decomposition temperature. Tomka, col. 13, lines 1-8. Such plasticizers solved the problem of the high volatility of water during processing because they have a vapor pressure of less than 1 bar at the melting temperature of the thermoplastic starch composition. *Id.* at col. 13, lines 10-12.

32. Tomka discloses and claims thermoplastic starch compositions in which the high boiling liquid plasticizer or "additive" is included in an amount of at least 5% by combined

weight of the starch and additive, with 10-30% being preferred. *Id.* at col. 6, lines 54-59; col. 13, lines 3-6. Tomka further teaches:

> Depending on the properties desired for the shaped body to be produced, such as thermal and mechanical properties in particular, about 10 to 35% plasticizer or additive respectively is preferably added to the native starch, the water of the starch being replaced by the addition of the additives or removed by drying.

Id. at col. 6, lines 54-59 (emphasis added).

33. In contrast to Tomka and Lorcks et al., the present application teaches that native starch granules can be initially melted using water, which is then removed by evaporation after the starch melt has been blended with one or more synthetic biodegradable polymers:

> Preferred thermoplastic starch polymers for use in making food wraps may advantageously utilize the natural water content of native starch granules to initially break down the granular structure and melt the native starch. Thereafter, the melted starch can be blended with one or more synthetic biopolymers, and the mixture dried by venting, in order to yield a final polymer blend.

Application, pp. 9-10, ¶ [0023]; *see* pp. 33-34, ¶¶ [0092]-[0094].

34. In contrast, Lorcks et al. does not disclose thermoplastic starch manufactured in this manner but teaches the use of TPS that includes 10-40% of a high boiling liquid plasticizer:

> Because of the poor suitability of native starch as an "engineering plastic" it is proposed according to the invention to use so-called thermoplastic starch, as is proposed, for example, in PCT/WO90/05161. This thermoplastic starch is obtained by processing native starch in the melt, by means of a plasticizing or swelling agent, to a homogeneous mass, where the proportion of swelling or plasticizing agent can as a rule amount to between 10 and about 40%, based on the overall weight of the mixture.

Lorcks et al., col. 1, line 62 – col. 2, line 6 (emphasis added).

35. In view of the foregoing, it is my opinion that thermoplastic starch that is "free of plasticizers" cannot be obtained following the teachings of Lorcks et al. and that claims 14 and 39-41, because they recite "thermoplastic starch that is "free of plasticizers", are patentable over Lorcks et al.

I declare further that all statements made herein of my own knowledge are true and that all statements are made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful, false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful, false statements may jeopardize the validity of the application or any patent issuing thereon.

Signed at SANTA BARBARA, California, this 9th day of January 2006.

Simon K. Hodson
Co-inventor

JMG0000000784V001

John M. Guynn

From: Randy Smith [rsmith@earthshell.com]
Sent: Saturday, September 17, 2005 6:06 PM
To: John M. Guynn
Subject: FW: Wrap formulations based on Biomax

From: Kishan Khemani
Sent: Monday, July 03, 2000 9:32 AM
To: Randy Smith
Subject: FW: Wrap formulations based on Biomax

Kishan

-----Original Message-----
From: Kishan Khemani
Sent: Sunday, July 02, 2000 9:34 PM
To: Simon Hodson
Cc: Kishan Khemani
Subject: Wrap formulations based on Biomax

Dear Simon,

The wrap formulations I am currently in the process of evaluating have the following range of materials:

50-70% Biomax 6926
5-20% Ecoflex F
10-20% of 'Unknown' Biomax grade
5-10% Talc
5-10% TiO2

Once the dryer is installed at Gemini, I plan to finish these tests and expect to have a recommended single formula (hopefully within the next 3-4 weeks).

My current problem is the identification of the 'unknown Biomax grade'. Originally, DuPont said that it was an amorphous grade, Biomax 6940; subsequently they have changed this story to first, Biomax 6926/Silica blend, and more recently to a low melt temperature grade, Biomax 6932. I need to know exactly what I am working with? For your information, the 6940 grade was originally developed by DuPont specifically for a Japanese company, and the application required an amorphous resin soluble in toluene. Apparently, I had received the shipment because of the mistake of a DuPont shipping person.

Any final film formulation will still need DuPont food-contact approvals and biodegradability compliance testing, before we can start marketing this product.

Thanks and regards,

Kishan

John M. Guynn

From: Randy Smith [rsmith@earthshell.com]
Sent: Saturday, September 17, 2005 6:08 PM
To: John M. Guynn
Subject: FW: REVIEW: Wrap Model
Importance: High
Attachments: Wrap Model - Rev 003 022001.xls

From: Matt Loos
Sent: Sunday, February 25, 2001 12:07 PM
To: Donna Balinkie; Kishan Khemani; Randy Smith
Cc: Matt Loos; Scott Houston
Subject: REVIEW: Wrap Model
Importance: High

Folks,

Please find attached the latest Wrap Model for INTERNAL review. This latest version requires a detailed review by those to whom this e-mail is addressed. Ideally, we would be face-to-face for this review, but there may be some tweaks to make before that session occurs this week. I welcome all input.

1) The Wrap model now contains a fairly exhaustive Assumptions tab. The Assumptions tab is the ONLY input area, and maintains all assumptions that drive the 'BioWrap' tabs. Please review for format and accuracy of assumptions
   a) **For BioWrap A**, I've changed the assumption for the ratio of Biomax/EcoFlex from 80/20 to 20/80. This was changed once the formulae for the Formulation section were improved (see Note 4) and effectively showed that there was not enough Ecoflex raw material to feed both the Masterbatch compounding and final compounding requirements. **Kishan** - I worked through these original assumptions with you. I may have transposed them incorrectly from the beginning, but nevertheless, I need you to verify and sign-off on the Raw Material and Formulation percentages presented in this version.

2) Per Scott's request, I have procured the Bioplast formulations from Biotec. This is **VERY SENSITIVE** data and was provided to me after I assured Harald that I would keep this information strictly confidential. Please help me retain my integrity and inside relationship with Biotec by exercising extreme caution with this information. Please do not share this information outside of our internal Wrap project team, i.e. those to whom this e-mail is addressed.

3) By understanding Biotec's formulation, I have now been able to compare the BioWrap A and G on an equal basis, when evaluating the economics of the Target - High Commerical Volume case. This information has allowed the model to demonstrated that, on Raw Material cost alone, these two wraps have similar economics.

4) The formulae for each BioWrap's Formulation section were improved in order to accept the detailed Bioplast formulation (The previous model version used an inherently limiting logic to drive the Raw Materials from the Formulation assumptions; This current version's logic more appropriately drives the Formulation from the Raw Material assumptions). Although BioWrap A does not use the Bioplast material, I wanted both comparisons (A & G) to treat the Formulation section in the same manner. This led to a fairly intense (IMHO) matrix to clearly show how a set of raw materials is compounded into masterbatches and then compounded again into the final resin to be blown. This matrix for both BioWrap A and G can be found on the "REF. ONLY - Calc" tab. This tab details the same calculations used on the 'BioWrap' tabs to derive the Formulation section.
   a) There is probably a better way to present how the Formulation percentages are calculated. The formulae are themselves not intense, but I believe the logic requires some 'quiet time'. I would like your review and input.

5) **Kishan/Randy** - I want to make absolutely sure that I have properly represented the raw materials relative to the masterbatches. For instance, does the "Whitener - TiO_2" raw material truly relate to the "Ecoflex / 64% $TiO_2/BaSO_4$"

nasterbatch?

Please note that all improvements to the model have focused on the BioWrap A &G ONLY. Hence, tabs not addressed are prefaced by a "NOT USED" in the tab names. I will return to the other samples (if need be) after we have collectively 'nailed' the format, etc for BioWraps A & G.

Thank you very much for your support and constructive criticism to improve the accuracy and usefulness of the Wrap Model.

Take Care,
Matt

EarthShell Corporation
Biodegradable Wrap Model

BioWrap G (ES #2), printed, paper-like tissue, 30 micron

Bioplast 105/30/W20, 3% SiO2, 3% TiO2, 22% CaCO2 filled, plain, paper-like tissue, 30 micron
15" x 15"

	Weight Mix ratios Fin.Prod.		Mstr Batch mat req'd g/piece		Minimum Commercial Volume Future Price/LB $	Minimum Commercial Volume Future Cost/1000 $	High Commercial Volume Target Price/LB $	High Commercial Volume Target Cost/1000 $
Raw Materials:								
Bioplast GF 105/30/W20:								
Ecoflex FBX	47.53%	(a)	1.16	(b)	1.01	2.63	0.97	4.28
PLA	20.37%	(a)					1.40	2.64
Loxamid	0.23%	(a)					2.48	0.05
Loxiol	0.23%	(a)					1.13	0.02
K21	0.23%	(a)					2.43	0.05
Masterbatch white	3.43%	(a)					1.90	0.60
Anti-block - SiO2	3.00%	(a)					0.14	0.04
Whitener - TiO2	3.00%	(a)					0.99	0.28
Inorganic Filler - CaCO3	22.00%	(a)					0.09	0.18
Raw Materials	100.00%		1.18			2.63		8.15
Formulation:								
Masterbatch Compounding:								
Bioplast GF 105/30/W20	50.3%		2.11	(b)	1.69	7.39	0.00	0.00
Ecoflex / (Assume) 60% SiO2	5.0%		0.21	(b)	1.50	0.69	0.00	0.00
Ecoflex / 64% TiO2/BaSO4	4.7%		0.20	(b)	1.66	0.72	0.00	0.00
Ecoflex / 55% CaCO3	40.0%		1.68	(b)	1.45	5.37	0.00	0.00
Formulation	100.0%		4.20			14.17		0.00
Combined film converting process			4.20		0.00	0.00	0.30	2.78
Separate converting processes								
Blowing:								
Gemini			4.20		0.36	3.33	0.00	0.00
Slitting:								
Gemini						0.83		0.00
Printing:								
No						0.00		0.00
Embossing:								
No						0.00		0.00
Sheeting:								
Associated						2.92		0.00
Separate converting processes						7.08		0.00
Cost of Manufacture						23.88		10.93
Markup	30%					7.16		3.28
Target Selling Price						31.05		14.21

Notes:
(a) Used for calculating High Commercial Volume cost per 1000; i.e. single compounding step.
(b) Used for calculating Minimum & Current Commercial Volume cost per 1000; ie dual compounding step.

EarthShell Corporation
Biodegradable Wrap Model
Check Formulation Calculation

BioWrap A

	Biomax 6926	Ecoflex FBX	Anti-block - SiO2	Whitener - TiO2	Inorganic Filler - CaCO3
1	13.40	53.60	3.00	5.00	25.00
2	-3.00	-23.27	-3.00	-5.00	-25.00
3	10.40	30.33	0.00	0.00	0.00

BioWrap G

	Bioplast GF 105/30/W20		Anti-block - SiO2	Whitener - TiO2	Inorganic Filler - CaCO3
1	72.00		3.00	3.00	22.00
2	-21.69		-3.00	-3.00	-22.00
3	50.31	0.00	0.00	0.00	0.00

Bioplast GF 105/30/W20

	Ecoflex FBX	PLA	Slipping Agent	Loxamid	Loxiol
1	0.6601	0.2829	0.0094	0.0031	0.0031
1a	47.5272	20.3688	0.6768	0.2233	0.2233
2	-21.6875				
	25.8397	20.3688	0.6768	0.2233	0.2233

	0.5	0.64	0.55	
Biomax / 50% SiO2		Ecoflex / 64% TiO2/BaSO4	Ecoflex / 55% CaCO3	Total
	0.00	0.00	0.00	100.00
	6.00	7.81	45.45	0.00
	6.00	7.81	45.45	100.00

	0.6	0.64	0.55	
Ecoflex / (Assume) 60% SiO2		Ecoflex / 64% TiO2/BaSO4	Ecoflex / 55% CaCO3	Total
	0.00	0.00	0.00	100.00
	5.00	4.69	40.00	0.00
	5.00	4.69	40.00	100.00

K21		Masterbatch white		Total
	0.0031	0.0476		1.00
	0.2233	3.4272		72.00
				-21.69
	0.2233	3.4272	0.0000	50.31

EarthShell Corporation
Biodegradable Wrap Model
Material & Process Pricing

Description	Low Volume Current	Minimum Commercial Volume Future	High Commercial Volume Target	Notes:
Inorganics - $ per pound				
Talc - SiO2	0.14	0.14	0.14	Verified with Randy
Whitener - TiO2	0.99	0.99	0.99	Verified with Randy
Limestone - CaCO2	0.09	0.09	0.09	Verified with Randy
Resin - $ per pound				
				Target price assumes compounding cost included.
Biomax 6926 - DuPont (Rigid)	1.20	1.00	1.00	$1.20 provided by Simon based upon talks with Dupont
Ecoflex FBX - BASF (Flexible)	1.23	1.01	0.97	5.80DM/kg up to 8,000 tons; 4.80DM<>4.60DM/kg up to 30,000 tons
Masterbatch Compounding by Biotec - $ per pound				
Bioplast GF 105/30/W20	1.59	1.59	1.27	7.50DM/kg for Low and Minimum Commercial = 6.0DM Raw Mat. + 1.5DM Compounding 6.00DM/kg for High Commercial = 4.5DM Raw Mat. + 1.5DM Compounding
Masterbatch Compounding by Techmer PM - $ per pound				Masterbatch compounding costs will remain relatively high without competition
applies to masterbatch only	1,000 lbs	40,000 lbs		
Ecoflex / 55% CaCO3	1.85	1.45		
Ecoflex / 64% TiO2/BaSO4	2.05	1.65		
Ecoflex / (Assume) 60% TiO2	1.90	1.50		
Biomax / 61% CaCO3	1.90	1.50		
Biomax / 53% TiO2/BaSO4	2.10	1.70		
Biomax / 50% SiO2	2.02	1.62		
Process - $ per pound				
Combined in-line (DuPont? BASF?)			0.30	Cocktail' produced at primary, but not blown.
Blowing - $ per pound				
Gemini Plastics	0.36	0.36		
Transamerica Plastics	0.52	0.32		
Polymer Packaging	0.35	0.32		
Casting - $ per pound				
Not Considered				Current
				Future
Slitting - $ per 1000				Given: $36/hr or $0.60/min. Assume:150 ft/min or 3600 in/min. Assume: 15"x15" part.
Gemini Plastics	0.18	0.18		Given: $36/hr or $0.60/min Assume 300 ft/min or 3600 in/min. Assume: 15"x15" part.

				Assume: 45" machine or 3 parts wide. So:3600 / 15 = 240 parts/min. So: 240 x 3 = 720 parts/min. So:1.0833 / 720 = $0.0015/part
Transamerican Plastics	0.33	0.33		Given: $65/hr or $1.0833/min. Assume:300 ft/min or 3600 in/min. Assume: 15"x15" part. Assume: 45" machine or 3 parts wide. So:3600 / 15 = 240 parts/min. So: 240 x 3 = 720 parts/min. So:1.0833 / 720 = $0.0015/part
Printing - $ per 1000				
Transamerican Plastics	2.90	2.90		Given: $125/hr or $2.0833/min. Assume:300 ft/min or 3600 in/min. Assume: 15"x15" part. Assume: 45" machine or 3 parts wide. So:3600 / 15 = 240 parts/min. So: 240 x 3 = 720 parts/min. So:2.0833 / 720 = $0.0029/part
Associated Polybag	2.80	2.80		Given: $120/hr or $2.00/min. Assume:300 ft/min or 3600 in/min. Assume: 15"x15" part. Assume: 45" machine or 3 parts wide. So:3600 / 15 = 240 parts/min. So: 240 x 3 = 720 parts/min. So:2.00 / 720 = $0.0028/part
Embossing - $ per 1000				
Gemini Plastics	1.00	1.00		Given: $45/hr or $0.75/min. Assume:300 ft/min or 3600 in/min. Assume: 15"x15" part. Assume: 45" machine or 3 parts wide. So:3600 / 15 = 240 parts/min. So: 240 x 3 = 720 parts/min. So:0.75 / 720 = $0.001/part
Transamerican Plastics	0.90	0.90		Given: $37/hr or $0.6167/min. Assume:300 ft/min or 3600 in/min. Assume: 15"x15" part. Assume: 45" machine or 3 parts wide. So:3600 / 15 = 240 parts/min. So: 240 x 3 = 720 parts/min. So:0.6167 / 720 = $0.0009/part
Sheeting - $ per 1000				
Transamerican Plastics	5.10	5.10		Given:$37/hr or $0.6167/min. Assume:120 parts/min. So:0.6167 / 120 = $0.0051/part Sheeting's limiting factor is 'catching' the sheeted wraps as they come off of the machine, i.e. manual limitation
Freight - $ per pound				
fob Primary Source	0.05	0.05	0.05	

EarthShell Corporation
Biodegradable Wrap Model

BioWrap B, clear, 37 micron
Ecomax 20/80, 5% SiO2, clear, 37 micron
15" x15"

	Weight Mix ratios Fin.Prod.		mat req'd g/piece		Minimum Commercial Volume Future Price/LB $	Minimum Commercial Volume Future Cost/1000 $	High Commercial Volume Target Price/LB $	High Commercial Volume Target Cost/1000 $
Raw Materials:								
Biomax 6926		(a)	0.31	(b)	1.00	0.67	1.00	0.67
Ecoflex FBX		(a)	0.00	(b)	1.01	0.00	0.97	0.00
Total Raw Materials			0.31			0.67		0.67
Formulation:								
Biomax 6926	70.0%		4.27	(b)	1.00	9.41	1.00	9.41
Ecoflex FBX	20.0%		1.22	(b)	1.01	2.73	0.97	2.62
Masterbatch Compounding:								
Biomax / 50% SiO2	10.0%		0.61	(b)	1.45	1.95	0.00	0.00
Total Formulation	100.0%		6.10			14.09		12.03
Combined film converting process			6.10		0.00	0.00	0.30	4.03
Separate converting processes								
Blowing:								
Gemini			6.10		0.36	4.84	0.00	0.00
Slitting:								
Gemini						0.18		0.00
Printing:								
No						0.00		0.00
Embossing:								
No						0.00		0.00
Sheeting:								
Transamerican						5.10		0.00
Separate converting processes						24.89		16.74
Cost of Manufacture						39.65		33.47
Markup	30%					11.90		10.04
Target Selling Price						51.55		43.51

Notes:
(a) Used for calculating High Commercial Volume cost per 1000; i.e. single compounding step.
(b) Used for calculating Minimum & Current Commercial Volume cost per 1000; ie dual compounding step.

EarthShell Corporation
Biodegradable Wrap Model

BioWrap C, printed, 25 micron
Bioplast 105/30/W20 Carl's Jr. print, 25 micron
14" x 14"

	Weight Mix ratios Fin.Prod.		mat req'd g/piece		Minimum Commercial Volume Future Price/LB $	Minimum Commercial Volume Future Cost/1000 $	High Commercial Volume Target Price/LB $	High Commercial Volume Target Cost/1000 $
Raw Materials:								
		(a)	0.00	(b)	0.00	0.00	0.00	0.00
		(a)	0.00	(b)	0.00	0.00	0.00	0.00
Total Raw Materials			0.00			0.00		0.00
Formulation:								
Masterbatch Compounding:								
Bioplast GF 105/30/W20	100.0%		5.00	(b)	1.59	17.48	1.27	13.98
			0.00	(b)	0.00	0.00	0.00	0.00
			0.00	(b)	0.00	0.00	0.00	0.00
Total Formulation	100.0%		5.00			17.48		13.98
Combined film converting process			5.00		0.00	0.00	0.30	3.31
Separate converting processes								
Blowing:								
Gemini			5.00		0.36	3.97	0.00	0.00
Slitting:								
Gemini						0.18		0.00
Printing:								
No						0.00		0.00
Embossing:								
No						0.00		0.00
Sheeting:								
Transamerican						5.10		0.00
Separate converting processes						26.72		17.29
Cost of Manufacture						44.20		34.58
Markup	30%					13.26		10.37
Target Selling Price						57.46		44.95

Notes:
(a) Used for calculating High Commercial Volume cost per 1000; i.e. single compounding step.
(b) Used for calculating Minimum & Current Commercial Volume cost per 1000; ie dual compounding step.

John M. Guynn

From: Randy Smith [rsmith@earthshell.com]
Sent: Saturday, September 17, 2005 6:09 PM
To: John M. Guynn
Subject: FW: UPDATE: Wrap Model 005
Attachments: Wrap Model - Rev 005 040501.xls

lohn:

ʾlease let me know if you need any more information. There is a lot more.

ʾAS

ʾrom: Matt Loos
ʾent: Friday, April 06, 2001 10:05 AM
ʾo: Donna Balinkie; John Nevling; Randy Smith; Kishan Khemani
ʾc: Matt Loos; Scott Houston
ʾubject: UPDATE: Wrap Model 005

ʾolks,

ʾesterday afternoon, Simon requested that I insert an additional tab to reflect the economics of substituting PLA for Biomax, using he Wrap L Biomax/Ecoflex formulation.

would appreciate your review and comments.

ʾhank you,
ʾlatt

EarthShell Corporation
Biodegradable Wrap Model

Version changes listed by date (most recent at top)

Color Key

Assumptions link/Input	Light Yellow
Linked to another tab	Turquoise (Color Scheme just under Turquoise)
Calculated	Lavender (Color Scheme just to the left of Lavender)
Drives a link to a tab	Light Green

Version 005 04-05-01 - Matt Loos

1- Added additional tab to reflect replacing Ecomax with Eastar

2- Updated General Assumptions for Eastar and new tab

3- Input notes regarding frieght and duty assumptions on Ecoflex

4- Updated Exchange rates

5- Added additional tab to reflect replacing Biomax with PLA

6- Updated General Assumption for PLA and new tab

7-

8-

9-

10-

11-

12-

Version 004 03-09-01 - Matt Loos
Version 003 02-20-01 - Matt Loos
Version 002 11-27-00 - Matt Loos
Version 001 11-13-00 - Matt Loos

<u>Version 000 11-07-00 - Matt Loos</u>

EarthShell Corporation
Biodegradable Wrap Model
Issues

1- What about vendor effeciencies? What are the Throughput assumptions.
2- Seek vendors that allow Blowing, Slitting, Printing & Winding as one process.
3- At this point, none of these steps are optimized
4-
5-
6-
7-
8-
9-
10-
11-
12-
13-

<u>Distribution - Internal Review - 02/28/01 - integral to wrap team</u>

A) Business Plan - Simon
- Bagkraft / Bourroughs
- Apply technology / single laminate material

B) Blowing, Printing, Sheeting, Slitting to $0.30 per pound - Randy
- requires formula to be 'locked-in'
- Tranamerican blowing capacity is 4500MT/year, OR 1/3 of printing capacity

C) Discussion with Dupont and BASF for 'cocktail' - Simon (Donna)
- Compounding in-line at the source

EarthShell Corporation
Biodegradable Wrap Model
Comparison Summary with Commercial Volume Pricing

PRODUCT	MATERIAL	BASIS WT (gm/sqM)	WRAP WT (gm)	WRAP SIZE	Avg $/sqM	$/LB	Avg $/1000
Current							
Famous/Big 4-Way	20#/24# Plastawrap	39.5	4.6	14 1/4"x13"	2.62	1.22	12.31
Western/Super 4-Way	20#/24# Plastawrap	39.5	5.6	15"x15"	2.57	1.20	14.70
Special/Burger Promo	20#/24# Plastawrap	39.5	5.6	15"x15"	2.62	1.20	14.99
Crispy Chickn Paper 4-Way	20#/24# Plastawrap	39.5	5.6	15"x15"	2.62	1.14	14.97
Chicken 4 Way Paper	20#/24# Plastawrap	39.5	4.5	13 1/2"x13"	2.86	1.18	11.82
Hamb/Chsbrgr/Fish/Promo	15#/18# Plastawrap			12 1/2"x13"			7.63
Sunrise/Burrito Foil	.00025/14# Paper (Foil)			10 1/2"x 11"			11.92
Typical High Quality Burger Wrap w/ Graphic	20#/24# Plastawrap	39.5	5.6	15" x 15"	2.62	1.20	14.99
Proposed							
Sandwich Wrap A - Biomax/Ecoflex, printed, 30 micron	See Wrap A tab		6.1	15" x 15"	3.18	1.35	18.18
Sandwich Wrap L - Biomax/Eastar - 50 micron	See Wrap L-BiomaxEastar tab		5.1	15" x 15"	2.94	1.50	16.79
Sandwich Wrap L - PLA/Ecoflex - 50 micron	See Wrap L-PLAEcoflex tab		5.1	15" x 15"	2.54	1.29	14.50
Sandwich Wrap L - Biomax/Ecoflex - 50 micron	See Wrap L-BiomaxEcoflex tab		5.1	15" x 15"	2.54	1.29	14.50

Notes:

Quick White (Collar)	16#/FC807			12"x12"			4.17

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
I. MODEL DESCRIPTION			Review 4 different Wrap formulations 2 formulations (A, L-BiomaxEcoflex) based upon Ecoflex/Biomax 1 formulation (L-BiomaxEastar) based upon Eastar MW/Biomax 1 formulation (L-PLAEcoflex) based upon Ecoflex/PLA		
II. PRODUCT CONFIGURATION					
Sandwich Wrap A - Biomax/Ecoflex, printed, 30 micron		15" x 15"	Ecomax 20/80, 3% SiO2, 5% TiO2, 25% CaCO2 filled, white, printed 4 colors, 30 micron		
Sandwich Wrap L - Biomax/Ecoflex - 50 micron		15" x 15"	50% Biomax - 4026, 15% Ecoflex / 35% Filler - ES4338		
Sandwich Wrap L - Biomax/Eastar - 50 micron		15" x 15"	50% Biomax - 4026, 15% Eastar MW / 35% Filler - ES4338		
Sandwich Wrap L - PLA/Ecoflex - 50 micron		15" x 15"	50% PLA, 15% Ecoflex / 35% Filler - ES4338		
III. PRODUCT FORMULATION (Weight mix ratios)					
All formulations (weight mix ratios) are controlled on the respective Wrap presentation tabs Wrap thickness (microns) is related to weight, but model drives from weight (grams) only.					
Bioplast GF 105/30/W20					
Ecoflex FBX	66.01%		% of Total Bioplast GF 105/30/W20		
PLA - Germany	28.29%		% of Total Bioplast GF 105/30/W20		
Slipping Agent	0.94%		% of Total Bioplast GF 105/30/W20		
Loxamid	33.33%		% of Total Slipping Agent		
Loxiol	33.33%		% of Total Slipping Agent		
K21	33.33%		% of Total Slipping Agent		
Masterbatch white	4.76%		% of Total Bioplast GF 105/30/W20		
Sandwich Wrap A - Biomax/Ecoflex, printed, 30 micron					
Total Wrap Weight	6.10	grams			5.4grams theoretical weight - Randy @ 02/23/01 5.1g current weight - Randy @ 02/23/01 5.83 without ink weight - Randy @ 02/23/01
Biomax 6926	80%	%	% of Biomax + Ecoflex		

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Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Ecoflex FBX	20%	%	% of Biomax + Ecoflex		
Talc - SiO2	3.0%	%	% of Total Wrap Weight		
Whitener - TiO2	5.0%	%	% of Total Wrap Weight		
Limestone - CaCO2	25.0%	%	% of Total Wrap Weight		
Sandwich Wrap L - Biomax/Ecoflex - 50 micron					
Total Wrap Weight	5.10	grams			
Raw Materials:					
Biomax 6926	50%	%	% of Total Wrap Weight		
Ecoflex FBX	15%	%	% of Total Wrap Weight		
Filler - Assume CaCO2	35%	%	% of Total Wrap Weight		
Formulation:					
Biomax 6926	50%	%	% of Total Wrap Weight		
PaperMatch ES4338	50%	%	% of Total Wrap Weight		
Sandwich Wrap L - Biomax/Eastar - 50 micron					
Total Wrap Weight	5.10	grams			
Raw Materials:					
Biomax 6926	50%	%	% of Total Wrap Weight		
Eastar MW - H	15%	%	% of Total Wrap Weight		
Filler - Assume CaCO2	35%	%	% of Total Wrap Weight		
Formulation:					
Biomax 6926	50%	%	% of Total Wrap Weight		
PaperMatch ES4338	50%	%	% of Total Wrap Weight		
Sandwich Wrap L - PLA/Ecoflex - 50 micron					
Total Wrap Weight	5.10	grams			
Raw Materials:					
PLA - Hycail B.V.	50%	%	% of Total Wrap Weight		
Ecoflex FBX	15%	%	% of Total Wrap Weight		
Filler - Assume CaCO2	35%	%	% of Total Wrap Weight		
Formulation:					
PLA - Hycail B.V.	50%	%	% of Total Wrap Weight		
PaperMatch ES4338	50%	%	% of Total Wrap Weight		

IV. RAW MATERIALS PRICING (FOB vendor)

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Low Volume			all prices are FOB Converter		Product design still not finalized.
Inorganics					
Anti-block - SiO2	$ 0.14	$/lb.	Randy verified price	95%	
Whitener - TiO2	$ 0.99	$/lb.	Randy verified price	95%	
Inorganic Filler - CaCO3	$ 0.09	$/lb.	Randy verified price	95%	
Resin					

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Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Biomax 4026 - DuPont (Rigid)	$ 1.18	$/lb.	$1.18 initial verbal quote provided by DuPont	50%	
Ecoflex FBX - BASF (Flexible)	5.80	DM/kg	Provided by H.Schmidt - 02/22/01		
Ecoflex FBX - BASF (Flexible)	$ 1.20	$/lb.	Assumes 'delivered price'		
Eastar MW - H	$ 2.00	$/lb.	High Grade - Provided by Kishan. Assumes 'delivered price'	90%	
Eastar MW - L	$ 1.83	$/lb.	Low Grade - Provided by Kishan. Assumes 'delivered price'	90%	
PLA - Hycail B.V. (Rigid)	$ 1.00	$/lb.	Provided by Kishan - verbal quote from Bill Kelly. Hycail U.S. prices not yet available		
Masterbatch Compounding by A. Schulman					
ES4228	$ 0.75	$/lb.	Proprietary - A.Schulman Inc.		Randy
% Filler - Assume CaCO3	70%		% of respective Masterbatch		
Masterbatch Compounding by Biotec					
Bioplast GF 105/30/W20	$ 7.50	DM/kg	Biotec Sales price = 6.22DM Raw Mat. + 1.28DM Compounding	95%	
Bioplast GF 105/30/W20	$ 1.55	$/lb.			
PLA - Germany	6.63	DM/kg	Provided by H.Schmidt - 02/22/01		
PLA - Germany	$ 1.37	$/lb.			
Loxamid (Slipping Agent)	11.80	DM/kg	Provided by H.Schmidt - 02/22/01		
Loxamid (Slipping Agent)	$ 2.45	$/lb.			
Loxiol (Slipping Agent)	5.35	DM/kg	Provided by H.Schmidt - 02/22/01		
Loxiol (Slipping Agent)	$ 1.11	$/lb.			
K21 (Slipping Agent)	11.48	DM/kg	Provided by H.Schmidt - 02/22/01		
K21 (Slipping Agent)	$ 2.38	$/lb.			
Masterbatch white	9.00	DM/kg	Provided by H.Schmidt - 02/22/01		BASF Proprietary composition; Consists mostly of TiO2 (60%??) and Ecoflex (40%??), but there is most likely other trace additives.
Masterbatch white	$ 1.87	$/lb.			

Bioplast GF 105/30/W20	$ 1.290	$/lb.	Derived Total raw material cost excluding compounding cost
Ecoflex FBX	$ 0.794	$/lb.	
PLA	$ 0.389	$/lb.	
Slipping Agent	$ 0.019	$/lb.	
Loxamid	$ 0.008	$/lb.	
Loxiol	$ 0.003	$/lb.	
K21	$ 0.007	$/lb.	
Masterbatch white	$ 0.089	$/lb.	

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Masterbatch Compounding by Techmer PM		1,000 lbs			Masterbatch compounding costs will remain relatively high without competition
Ecoflex / 55% CaCO3	$ 1.85	$/lb.	Kishan Memo - 11/06/00	95%	
% CaCO3	55.0%		% of respective Masterbatch		
Ecoflex / 64% TiO2/BaSO4	$ 2.05	$/lb.	Kishan Memo - 11/06/00	95%	
% TiO2/BaSO4	64.0%		% of respective Masterbatch		
Ecoflex / (Assume) 60% SiO2	$ 1.90	$/lb.	Kishan Memo - 11/06/00	95%	
% TiO2	60.0%		% of respective Masterbatch		
Biomax / 61% CaCO3	$ 1.90	$/lb.	Kishan Memo - 11/06/00	95%	
% CaCO3	61.0%		% of respective Masterbatch		
Biomax / 53% TiO2/BaSO4	$ 2.10	$/lb.	Kishan Memo - 11/06/00	95%	
% TiO2/BaSO4	53.0%		% of respective Masterbatch		
Biomax / 50% SiO2	$ 2.02	$/lb.	Kishan Memo - 11/06/00	95%	
% SiO2	50.0%		% of respective Masterbatch		
In-line Process					
Combined in-line	$ -	$/lb.	Blow, Slit, (Embosse), Print & Sheet		Converter is not yet identified Dupont will not convert.
Blowing			Integral to in-line process		This process step not optimized
Gemini Plastics	$ 0.36	$/lb.			
Transamerican Plastics	$ 0.52	$/lb.			
Polymer Packaging	$ 0.35	$/lb.			
Slitting			Integral to in-line process		This process step not optimized
Gemini Plastics					
Machine/Labor rate	$ 36.00	$/hour			
Machine speed	150.0	ft/min	Represents speed of slowest process in-line		
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	120.0	parts/min			
Parts per minute on given machine	360.0	parts/min			
Cost per part	$ 0.00167	$/part			
Transamerican Plastics					
Machine/Labor rate	$ 65.00	$/hour			
Machine speed	150.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	120.0	parts/min			
Parts per minute on given machine	360.0	parts/min			
Cost per part	$ 0.00301	$/part			
Printing			Integral to in-line process		This process step not optimized

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Associated Polybag					
Machine/Labor rate	$ 120.00	$/hour			
Machine speed	150.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	120.0	parts/min			
Parts per minute on given machine	360.0	parts/min			
Cost per part	$ 0.00556	$/part			
Transamerican Plastics					
Machine/Labor rate	$ 125.00	$/hour			
Machine speed	150.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	120.0	parts/min			
Parts per minute on given machine	360.0	parts/min			
Cost per part	$ 0.00579	$/part			
Embossing			Integral to in-line process		This process step not optimized
Gemini Plastics					
Machine/Labor rate	$ 45.00	$/hour			
Machine speed	150.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	120.0	parts/min			
Parts per minute on given machine	360.0	parts/min			
Cost per part	$ 0.00208	$/part			
Transamerican Plastics					
Machine/Labor rate	$ 37.00	$/hour			
Machine speed	150.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	120.0	parts/min			
Parts per minute on given machine	360.0	parts/min			
Cost per part	$ 0.00171	$/part			
Sheeting			Not part of in-line process		This process step not optimized
Associated					
Machine/Labor rate	$ 35.00	$/hour			
Machine speed	63.3	ft/min			
Machine width	45.0	in			

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	66.6	parts/min			
Parts per minute on given machine	199.9	parts/min	100 ppm per lane; 2 lanes		Specific Sheeter equipment exists, so that the Bagger would not need to be modified
Cost per part	$ 0.00292	$/part			
Transamerican Plastics					
Machine/Labor rate	$ 37.00	$/hour			
Machine speed	50.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	40.0	parts/min			
Parts per minute on given machine	120.0	parts/min	Sheeting's limiting factor is 'catching' the sheeted wraps as they come off of the machine, i.e. manual limitation		
Cost per part	$ 0.00514	$/part			
Minimum Commercial Volume			all prices are FOB Converter		Product design still not finalized.
Inorganics					
Anti-block - SiO2	$ 0.14	$/lb.	Randy verified price	95%	
Whitener - TiO2	$ 0.99	$/lb.	Randy verified price	95%	
Inorganic Filler - CaCO3	$ 0.09	$/lb.	Randy verified price	95%	
Resin					
Biomax 4026 - DuPont (Rigid)	$ 1.00	$/lb.	$1.00 provided by Simon based upon perceived economies with volume	10%	
Ecoflex FBX - BASF (Flexible)	4.80	DM/kg	Provided by H.Schmidt based upon general talks with BASF; up to 30,000MT		
Ecoflex FBX - BASF (Flexible)	$ 1.00	$/lb.	Assumes 'delivered price'		
Eastar MW - H	$ 2.00	$/lb.	High Grade - Provided by Kishan. Assumes 'delivered price'	90%	
Eastar MW - L	$ 1.83	$/lb.	Low Grade - Provided by Kishan. Assumes 'delivered price'	90%	
PLA - Hycail B.V. (Rigid)	$ 1.00	$/lb.	Provided by Kishan - verbal quote from Bill Kelly. Hycail U.S. prices not yet available		
Masterbatch Compounding by A. Schulman					
ES4228	$ 0.75	$/lb.	Proprietary - A.Schulman Inc.		Randy
% Filler - Assume CaCO3	70%		% of respective Masterbatch		

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Masterbatch Compounding by Biotec					
Bioplast GF 105/30 (Wrap)	7.50	DM/kg	Biotec Sales price = 6.50DM Raw Mat. + 1.5DM Compounding	95%	
Bioplast GF 105/30 (Wrap)	$ 1.55	$/lb.			
PLA - Germany	6.63	DM/kg	Provided by H.Schmidt - 02/22/01		
PLA - Germany	$ 1.37	$/lb.			
Loxamid (Slipping Agent)	11.80	DM/kg	Provided by H.Schmidt - 02/22/01		
Loxamid (Slipping Agent)	$ 2.45	$/lb.			
Loxiol (Slipping Agent)	5.35	DM/kg	Provided by H.Schmidt - 02/22/01		
Loxiol (Slipping Agent)	$ 1.11	$/lb.			
K21 (Slipping Agent)	11.48	DM/kg	Provided by H.Schmidt - 02/22/01		
K21 (Slipping Agent)	$ 2.38	$/lb.			
Masterbatch white	9.00	DM/kg	Provided by H.Schmidt - 02/22/01		Can Biotec compound this, or always 3rd pty sourced?
Masterbatch white	$ 1.87	$/lb.			
Bioplast GF 105/30/W20	$ 1.153	$/lb.	Derived Total raw material cost excluding compounding cost		
Ecoflex FBX	$ 0.657	$/lb.			
PLA	$ 0.389	$/lb.			
Slipping Agent	$ 0.019	$/lb.			
Loxamid	$ 0.008	$/lb.			
Loxiol	$ 0.003	$/lb.			
K21	$ 0.007	$/lb.			
Masterbatch white	$ 0.089	$/lb.			
Masterbatch Compounding by Techmer PM		1,000 lbs			Masterbatch compounding costs will remain relatively high without competition
Ecoflex / 55% CaCO3	$ 1.45	$/lb.	Kishan Memo - 11/06/00	95%	
Ecoflex / 64% TiO2/BaSO4	$ 1.65	$/lb.	Kishan Memo - 11/06/00	95%	
Ecoflex / (Assume) 60% TiO2	$ 1.50	$/lb.	Kishan Memo - 11/06/00	95%	
Biomax / 61% CaCO3	$ 1.50	$/lb.	Kishan Memo - 11/06/00	95%	
Biomax / 53% TiO2/BaSO4	$ 1.70	$/lb.	Kishan Memo - 11/06/00	95%	
Biomax / 50% SiO2	$ 1.62	$/lb.	Kishan Memo - 11/06/00	95%	
In-line Process					
Combined in-line	$ -	$/lb.	Blow, Slit, (Embosse), Print & Sheet		Converter is not yet identified Dupont will not convert.
Blowing			Integral to in-line process		This process step not optimized
Gemini Plastics	$ 0.36	$/lb.			
Transamerican Plastics	$ 0.32	$/lb.			
Polymer Packaging	$ 0.32	$/lb.			

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Slitting					
Gemini Plastics			Integral to in-line process		This process step not optimized
Machine/Labor rate	$ 36.00	$/hour			Rate for higher volumes unknown. Assume same as low volumes
Machine speed	300.0	ft/min	Represents speed of slowest process in-line		Assumes improvement in machine speeds
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ 0.00083	$/part			
Transamerican Plastics					
Machine/Labor rate	$ 65.00	$/hour			Rate for higher volumes unknown. Assume same as low volumes
Machine speed	300.0	ft/min			Assumes improvement in machine speeds
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ 0.00150	$/part			
Printing			Integral to in-line process		This process step not optimized
Associated Polybag					
Machine/Labor rate	$ 120.00	$/hour			Rate for higher volumes unknown. Assume same as low volumes
Machine speed	300.0	ft/min			Assumes improvement in machine speeds
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ 0.00278	$/part			
Transamerican Plastics					
Machine/Labor rate	$ 125.00	$/hour			Rate for higher volumes unknown. Assume same as low volumes
Machine speed	300.0	ft/min			Assumes improvement in machine speeds
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ 0.00289	$/part			

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Embossing			Integral to in-line process		This process step not optimized
Gemini Plastics					
Machine/Labor rate	$ 45.00	$/hour			Rate for higher volumes unknown. Assume same as low volumes
Machine speed	300.0	ft/min			Assumes improvement in machine speeds
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ 0.00104	$/part			
Transamerican Plastics					
Machine/Labor rate	$ 37.00	$/hour			Rate for higher volumes unknown. Assume same as low volumes
Machine speed	300.0	ft/min			Assumes improvement in machine speeds
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ 0.00086	$/part			
Sheeting			Not part of in-line process		This process step not optimized
Associated					
Machine/Labor rate	$ 35.00	$/hour			
Machine speed	83.3	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	66.6	parts/min			
Parts per minute on given machine	199.9	parts/min	100 ppm per lane; 2 lanes		Specific Sheeter equipment exists, so that the Bagger would not need to be modified
Cost per part	$ 0.00292	$/part			
Transamerican Plastics					
Machine/Labor rate	$ 37.00	$/hour			Rate for higher volumes unknown. Assume same as low volumes
Machine speed	50.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	40.0	parts/min			

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Parts per minute on given machine	120.0	parts/min	Sheeting's limiting factor is 'catching' the sheeted wraps as they come off of the machine, i.e. manual limitation		
Cost per part	$ 0.00514	$/part			
High Commercial Volume			all prices are FOB Converter		Product design still not finalized.
Inorganics					
Anti-block - SIO2	$ 0.14	$/lb.	Randy verified price	95%	
Whitener - TiO2	$ 0.99	$/lb.	Randy verified price	95%	
Inorganic Filler - CaCO3	$ 0.09	$/lb.	Randy verified price	95%	
Resin					
Biomax 4026 - DuPont (Rigid)	$ 1.00	$/lb.	$1.00 provided by Simon based upon perceived economies with volume	10%	
Ecoflex FBX - BASF (Flexible)	4.60	DM/kg	Provided by H.Schmidt based upon general talks with BASF; up to 30,000MT		
Ecoflex FBX - BASF (Flexible)	$ 0.95	$/lb.	Assumes 'delivered price'		
Eastar MW - H	$ 2.00	$/lb.	High Grade - Provided by Kishan. Assumes 'delivered price'	90%	
Eastar MW - L	$ 1.83	$/lb.	Low Grade - Provided by Kishan. Assumes 'delivered price'	90%	
PLA - Hycail B.V. (Rigid)	$ 1.00	$/lb.	Provided by Kishan - verbal quote from Bill Kelly. Hycail U.S. prices not yet available		
Masterbatch Compounding by A. Schulman					
ES4228	$ -	$/lb.	Proprietary - A.Schulman Inc.		Randy
% Filler - Assume CaCO3	70%		% of respective Masterbatch		
Masterbatch Compounding by Biotec					
Bioplast GF 105/30 (Wrap)	6.00	DM/kg	Biotec Sales price = 4.50DM Raw Mat. + 1.5DM Compounding	50%	
Bioplast GF 105/30 (Wrap)	$ 1.24	$/lb.			
PLA - Germany	6.63	DM/kg	Provided by H.Schmidt - 02/22/01		
PLA - Germany	$ 1.37	$/lb.			
Loxamid (Slipping Agent)	11.80	DM/kg	Provided by H.Schmidt - 02/22/01		
Loxamid (Slipping Agent)	$ 2.45	$/lb.			
Loxiol (Slipping Agent)	5.35	DM/kg	Provided by H.Schmidt - 02/22/01		
Loxiol (Slipping Agent)	$ 1.11	$/lb.			
K21 (Slipping Agent)	11.48	DM/kg	Provided by H.Schmidt - 02/22/01		
K21 (Slipping Agent)	$ 2.38	$/lb.			

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open Items and assignments
Masterbatch white	9.00	DM/kg	Provided by H.Schmidt - 02/22/01		Can Biotec compound this, or always 3rd pty sourced?
Masterbatch white	$ 1.87	$/lb.			
			Derived Total raw material cost excluding compounding cost		
Bioplast GF 105/30/W20	$ 1.126	$/lb.			
Ecoflex FBX	$ 0.629	$/lb.			
PLA	$ 0.369	$/lb.			
Slipping Agent	$ 0.019	$/lb.			
Loxamid	$ 0.008	$/lb.			
Loxiol	$ 0.003	$/lb.			
K21	$ 0.007	$/lb.			
Masterbatch white	$ 0.089	$/lb.			
Masterbatch Compounding by Techmer PM		40000 lbs			Masterbatch compounding costs will remain relatively high without competition
Ecoflex / 55% CaCO3	$ -	$/lb.	Assumes cocktail produced at primary		
Ecoflex / 64% TiO2/BaSO4	$ -	$/lb.	Assumes cocktail produced at primary		
Ecoflex / (Assume) 60% TiO2	$ -	$/lb.	Assumes cocktail produced at primary		
Biomax / 61% CaCO3	$ -	$/lb.	Assumes cocktail produced at primary		
Biomax / 53% TiO2/BaSO4	$ -	$/lb.	Assumes cocktail produced at primary		
Biomax / 50% SiO2	$ -	$/lb.	Assumes cocktail produced at primary		
In-line Process					
Combined in-line	$ 0.30	$/lb.	Blow, Slit, (Embosse), Print & Sheet		Converter is not yet identified Dupont will not convert.
Blowing			Integral to in-line process		This process step not optimized
Gemini Plastics	$ -	$/lb.	In-line Process precludes this cost		
Transamerican Plastics	$ -	$/lb.	In-line Process precludes this cost		
Polymer Packaging	$ -	$/lb.	In-line Process precludes this cost		
Slitting					
Gemini Plastics			Integral to in-line process		This process step not optimized
Machine/Labor rate	$ -	$/hour	In-line Process precludes this cost		Rate for higher volumes unknown. Assume same as low volumes
Machine speed	300.0	ft/min	Represents speed of slowest process in-line		Assumes improvement in machine speeds
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ -	$/part			
Transamerican Plastics					

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
					Rate for higher volumes unknown. Assume same as low volumes
Machine/Labor rate	$ -	$/hour	In-line Process precludes this cost		Assumes improvement in machine speeds
Machine speed	300.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ -	$/part			
Printing			Integral to in-line process		This process step not optimized
Associated Polybag					
					Rate for higher volumes unknown. Assume same as low volumes
Machine/Labor rate	$ -	$/hour	In-line Process precludes this cost		Assumes improvement in machine speeds
Machine speed	300.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ -	$/part			
Transamerican Plastics					
					Rate for higher volumes unknown. Assume same as low volumes
Machine/Labor rate	$ -	$/hour	In-line Process precludes this cost		Assumes improvement in machine speeds
Machine speed	300.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ -	$/part			
Embossing			Integral to in-line process		This process step not optimized
Gemini Plastics					
					Rate for higher volumes unknown. Assume same as low volumes
Machine/Labor rate	$ -	$/hour	In-line Process precludes this cost		Assumes improvement in machine speeds
Machine speed	300.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ -	$/part			
Transamerican Plastics					

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Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Machine/Labor rate	$ -	$/hour	In-line Process precludes this cost		Rate for higher volumes unknown. Assume same as low volumes
Machine speed	300.0	ft/min			Assumes improvement in machine speeds
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	240.0	parts/min			
Parts per minute on given machine	720.0	parts/min			
Cost per part	$ -	$/part			
Sheeting			Not part of in-line process		This process step not optimized
Associated					
Machine/Labor rate	$ -	$/hour			
Machine speed	83.3	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	66.6	parts/min			
Parts per minute on given machine	199.9	parts/min			
Cost per part	$ -	$/part			
Transamerican Plastics					
Machine/Labor rate	$ -	$/hour	In-line Process precludes this cost		Rate for higher volumes unknown. Assume same as low volumes
Machine speed	50.0	ft/min			
Machine width	45.0	in			
Part width	15.0	in	Assume part no greater than 15" x 15"		
Parts wide	3.0	parts			
Parts per minute (single width)	40.0	parts/min			
Parts per minute on given machine	120.0	parts/min	Sheeting's limiting factor is 'catching' the sheeted wraps as they come off of the machine, i.e. manual limitation		
Cost per part	$ -	$/part			

V. Freight costs:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Between converters (Truck)	$ 0.05	$/lb		75%	Generally accepted rate
Germany to Baltimore - 40' Container					
Duty	7.00%	% of Value	T.T.C. - 02/16/01 quote	95%	Randy sourced this quote
Customs Entry	$ 145.00	$/40' cntnr	T.T.C. - 02/16/01 quote	95%	Randy sourced this quote
Ocean Freight	$ 3,850.00	$/40' cntnr	T.T.C. - 02/16/01 quote	95%	Randy sourced this quote
Trucking	$ 325.00	$/40' cntnr	T.T.C. - 02/16/01 quote	95%	Randy sourced this quote
Messenger	$ 15.00	$/40' cntnr	T.T.C. - 02/16/01 quote	95%	Randy sourced this quote

EarthShell Corporation

Biodegradable Wrap Model

Assumptions:

	Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
VI.	**Energy costs:**		**$/k pieces**			Toll manufacturing
VII.	**Labor Rates:**		**$/hour**			Toll manufacturing
	Skill Level:					
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	Salary Level:					
	1					
	2					
	3					
	4					
	5					
	6					
	7					
	Fringe Benefits					
	OT premium - average					
VII.	**Direct Labor Staffing**		**Heads/line**	**Requires Skill level:**		Toll manufacturing
VIII.	**Nameplate capacity**	27,610		product per hour		
	Products/platen	32	pieces			
	Cycle time (sec)	67	sec			
	# presses/line (module)	8	presses			
	# of Lines	2	lines			
IX.	**Planned Operating Hours**					Toll manufacturing
X.	**Quality Expectations (material efficiency) at each point for potential loss due to imperfect parts**					Toll manufacturing
XI.	**Uptime Expectations for each unit operation (operating efficiency)**					

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Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments

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Biodegradable Wrap Model

Assumptions:

Assumption	Value	Units	Detail Description	Assumption Confidence	Open items and assignments
Manufacturing Overhead					
XII. Indirect Staffing		Heads/line	Requires Skill level:		Toll manufacturing
XIII. Other Semi Variable Plant Overhead					
Percent in lieu of $ detail	0.0%				Toll manufacturing
XIV. Fixed Plant Overhead					
Plant management:		Heads/line	Requires Salary level:		Toll manufacturing
SG&A	0%	%			
Capital					
CapEx Contingency	0%				Toll manufacturing
Capital Installation	0%				Toll manufacturing
Capital Life	0	years	Straight line	100%	Toll manufacturing
Assumptions working capital					
-inventory materials 2 weeks				0%	
-inventory finished goods 2 weeks				0%	
-trade receivables 1 month				0%	
-trade payables 1 month				0%	

EarthShell Corporation
Biodegradable Wrap Model

Sandwich Wrap L - PLA/Ecoflex - 50 micron
50% PLA, 15% Ecoflex / 35% Filler - ES4338
15" x 15"

	Weight Mix ratios Fin.Prod.	Mstr Batch mat req'd g/piece	Minimum Commercial Volume Future Price/LB $	Minimum Commercial Volume Future Cost/1000 $	High Commercial Volume Target Price/LB $	High Commercial Volume Target Cost/1000 $
Raw Materials:						
PLA - Hycail B.V.	50.0% (a)	(b)	1.00	0.00	1.00	5.62
Ecoflex FBX	15.0% (a)	0.77 (b)	1.00	1.68	0.95	1.61
Filler - Assume CaCO2	35.0% (a)				0.14	0.55
Total Raw Materials	100.0%			1.68		7.78
Formulation:						
PLA - Hycail B.V.	50.0%	2.55 (b)	1.00	5.62	0.00	0.00
Masterbatch Compounding (cost incl. inorganics):						
PaperMatch ES4338	50.0%	2.55 (b)	0.75	4.22	0.00	0.00
Total Formulation	100.0%	5.10		\9.84		0.00
Subtotal Raw Mat./Formulation				11.52		7.78
Combined film converting process		5.10	0.00	0.00	0.30	3.37
Separate converting processes						
Blowing:						
Gemini		5.10	0.36	4.05	0.00	0.00
Printing:						
Associated				2.78		0.00
Embossing:						
No				0.00		0.00
Sheeting/Slitting:						
Associated				2.92		0.00
Separate converting processes				9.74		0.00
Cost of Manufacture				21.26		11.15
Markup	30%			6.38		3.35
Target Selling Price				27.64		14.50

Notes:
(a) Used for calculating High Commercial Volume cost per 1000; i.e. single compounding step.
(b) Used for calculating Minimum & Current Commercial Volume cost per 1000; ie dual compounding step.

EarthShell Corporation
Biodegradable Wrap Model

Sandwich Wrap L - Biomax/Eastar - 50 micron
50% Biomax - 4026, 15% Eastar MW / 35% Filler - ES4338
15" x 15"

	Weight Mix ratios Fin.Prod.	Mstr Batch mat req'd g/piece	Minimum Commercial Volume Future Price/LB $	Minimum Commercial Volume Future Cost/1000 $	High Commercial Volume Target Price/LB $	High Commercial Volume Target Cost/1000 $
Raw Materials:						
Biomax 6926	50.0% (a)	(b)	1.00	0.00	1.00	5.62
Eastar MW - H	15.0% (a)	0.77 (b)	2.00	3.37	2.00	3.37
Filler - Assume CaCO2	35.0% (a)				0.14	0.55
Total Raw Materials	100.0%			3.37		9.55
Formulation:						
Biomax 6926	50.0%	2.55 (b)	1.00	5.62	0.00	0.00
Masterbatch Compounding (cost incl. inorganics):						
PaperMatch ES4338	50.0%	2.55 (b)	0.75	4.22	0.00	0.00
Total Formulation	100.0%	5.10		9.84		0.00
Subtotal Raw Mat./Formulation				13.21		9.55
Combined film converting process		5.10	0.00	0.00	0.30	3.37
Separate converting processes						
Blowing:						
Gemini		5.10	0.36	4.05	0.00	0.00
Printing:						
Associated				2.78		0.00
Embossing:						
No				0.00		0.00
Sheeting/Slitting:						
Associated				2.92		0.00
Separate converting processes				9.74		0.00
Cost of Manufacture				22.95		12.92
Markup	30%			6.89		3.88
Target Selling Price				29.84		16.79

Notes:
(a) Used for calculating High Commercial Volume cost per 1000; i.e. single compounding step.
(b) Used for calculating Minimum & Current Commercial Volume cost per 1000; ie dual compounding step.

EarthShell Corporation
Biodegradable Wrap Model

Sandwich Wrap L - Biomax/Ecoflex - 50 micron

50% Biomax - 4026, 15% Ecoflex / 35% Filler - ES4338
15" x 15"

	Weight Mix ratios Fin.Prod.	Mstr Batch mat req'd g/piece	Minimum Commercial Volume Future Price/LB $	Minimum Commercial Volume Future Cost/1000 $	High Commercial Volume Target Price/LB $	High Commercial Volume Target Cost/1000 $
Raw Materials:						
Biomax 6926	50.0% (a)	(b)	1.00	0.00	1.00	5.62
Ecoflex FBX	15.0% (a)	0.77 (b)	1.00	1.68	0.95	1.61
Filler - Assume CaCO2	35.0% (a)				0.14	0.55
Total Raw Materials	100.0%			1.68		7.78
Formulation:						
Biomax 6926	50.0%	2.55 (b)	1.00	5.62	0.00	0.00
Masterbatch Compounding (cost incl. inorganics):						
PaperMatch ES4338	50.0%	2.55 (b)	0.75	4.22	0.00	0.00
Total Formulation	100.0%	5.10		9.84		0.00
Subtotal Raw Mat./Formulation				11.52		7.78
Combined film converting process		5.10	0.00	0.00	0.30	3.37
Separate converting processes						
Blowing:						
Gemini		5.10	0.36	4.05	0.00	0.00
Printing:						
Associated				2.78		0.00
Embossing:						
No				0.00		0.00
Sheeting/Slitting:						
Associated				2.92		0.00
Separate converting processes				9.74		0.00
Cost of Manufacture				21.26		11.15
Markup	30%			6.38		3.35
Target Selling Price				27.64		14.50

Notes:
(a) Used for calculating High Commercial Volume cost per 1000; i.e. single compounding step.
(b) Used for calculating Minimum & Current Commercial Volume cost per 1000; ie dual compounding step.

EarthShell Corporation
Biodegradable Wrap Model

Sandwich Wrap A - Biomax/Ecoflex, printed, 30 micron

Ecomax 20/80, 3% SiO2, 5% TiO2, 25% CaCO2 filled, white, printed 4 colors, 30 micron

15" x 15"

	Weight Mix ratios Fin.Prod.	Mstr Batch mat req'd g/piece	Minimum Commercial Volume Future Price/LB $	Minimum Commercial Volume Future Cost/1000 $	High Commercial Volume Target Price/LB $	High Commercial Volume Target Cost/1000 $
Raw Materials:						
Biomax 6926	53.6% (a)	0.18 (b)	1.00	0.40	1.00	7.21
Ecoflex FBX	13.4% (a)	1.72 (b)	1.00	3.77	0.95	1.72
Anti-block - SiO2	3.0% (a)				0.14	0.06
Whitener - TiO2	5.0% (a)				0.99	0.67
Inorganic Filler - CaCO3	25.0% (a)				0.09	0.30
Total Raw Materials	100.0%			4.18		9.95
Formulation:						
Biomax 6926	30.2%	1.84 (b)	1.00	4.06	0.00	0.00
Ecoflex FBX	13.4%	0.82 (b)	1.00	1.79	0.00	0.00
Masterbatch Compounding (cost incl. inorganics):						
Biomax / 50% SiO2	6.0%	0.37 (b)	1.62	1.31	0.00	0.00
Biomax / 53% TiO2/BaSO4	9.4%	0.58 (b)	1.70	2.16	0.00	0.00
Biomax / 61% CaCO3	41.0%	2.50 (b)	1.50	8.27	0.00	0.00
Total Formulation	100.0%	6.10		17.58		0.00
Subtotal Raw Mat./Formulation				21.76		9.95
Combined film converting process		6.10	0.00	0.00	0.30	4.03
Separate converting processes						
Blowing:						
Gemini		6.10	0.36	4.84	0.00	0.00
Printing:						
Associated				2.78		0.00
Embossing:						
No				0.00		0.00
Sheeting/Slitting:						
Associated				2.92		0.00
Separate converting processes				10.54		0.00
Cost of Manufacture				32.30		13.99
Markup	30%			9.69		4.20
Target Selling Price				41.99		18.18

Notes:
(a) Used for calculating High Commercial Volume cost per 1000; i.e. single compounding step.
(b) Used for calculating Minimum & Current Commercial Volume cost per 1000; ie dual compounding step.

John M. Guynn

From: Randy Smith [rsmith@earthshell.com]
Sent: Saturday, September 17, 2005 6:03 PM
To: John M. Guynn
Subject: FW: Re-Revised Wrap plan

Attachments: Microsoft Excel 2.x

EarthShell
ıPont Test Plan wr

John, here is a test plan. Note that the Papermatch grades were developed with A. Schulman and us as Eastar Bio resin as a base and talc, caco3 and tio2 fillers.

RAS

-----Original Message-----
From: Kishan Khemani
Sent: Saturday, June 23, 2001 5:52 PM
To: Jeffrey L McGlaughlin (E-mail); Jennifer M Schneider (E-mail); John Kelly (E-mail); John Nevling; Ken Atwood (E-mail); Randy Smith; Roger Byrd (E-mail); Donna Balinkie
Cc: Kishan Khemani; Lori Bowles; Simon Hodson
Subject: Re-Revised Wrap plan

Based on the learning's gleaned from previous wrap trials and because we feel that we are very close to a final product (even in the monolayer wrap that was printed, and the outcome of the Next Gen run#2), we would like to suggest that we conduct three experiments on July 5th-6th at Chestnut Run. I have modified the plan template to reflect this. Also note specifically the notes 1 and 2 in the test plan. Based upon our observations during the trial we will make adjustments in the formula and repeat the three structures. Please review ASAP and give me your comments. Thank you.

Kishan Khemani
Director, Bio Polymer Materials Research
Tel: 805-897-2233, 805-897-2299
Cell: 805-570-8134; Fax: 805-965-5329
kkhemani@earthshell.com

-----Original Message-----
From: Jennifer M Schneider [mailto:Jennifer.M.Schneider@usa.dupont.com]
Sent: Friday, June 22, 2001 2:34 PM
To: Donna Balinkie; John Nevling; John L. Kelley; Kishan Khemani; Randy Smith; Kenneth B Atwood; Jeffrey L McGlaughlin; Roger N Byrd
Subject: Revised Wrap plan

This is the revised plan
(See attached file: EarthShell DuPont Test Plan wraps.xls)

disregard previous sent by mistake

E[illegible]RTHSHELL-DUPONT TEST PL[illegible]

6/21/01

Test Title	Wraps Coextrusion Trials						
Date Planned	06/22/01	**Dates of Test**	7/5 and 7/6	**Location/Facility**	Chestnut Run Bldg 712		
Overall Purpose of Test	Produce a film that would be acceptable to take to Carls Jr.						
Specific Goals of Test	Determine processing conditions for each structure						
	Film thickness. Target is 1.5 mil nominal						
	If time permits, we will also make samples of thinner film at 0.75 mil nominal thickness						
Type of Equipment Needed	Coextrusion cast film line						
Materials Needed	**Description**	**Amount**	**Source**	**Resp.**	**By When**	**Verified**	
	Biomax	3,000 lbs	DuPont	JMS	2-Jul	J. Kelley	
	Papermatch T3818	2,000 lbs	Earthshell	R.Smith	2-Jul	J. Kelley	
	Papermatch T5346	1,000 lbs	Earthshell	R.Smith	2-Jul	J. Kelley	
	Papermatch T4338	1,000 lbs	Earthshell	R.Smith	2-Jul	J. Kelley	
	Eastar Bio	3,000 lbs	Earthshell	R.Smith	2-Jul	J. Kelley	
Test Coverage	**Who**	**Role in Test**	**Test Safety Information**				
	J. Kelley	Process knowledge consultant	Safety glasses and safety shoes must be worn				
	K. Khemani	Earthshell Technical					
	R. Byrd	Dupont Technical					
Samples Required	Frequency, amount, labels, etc.	500 feet of each film produced					

Facilities Plan	Who Schedules Facility	Is it Scheduled	Specific Time Scheduled	Arrive Time	Start Time	Must End Time	Facilities Contact	Facilities Address	Facilities Phone #
	JMS	Yes	Yes	7 am	7 am	5pm	Jim Smith	Chestnut run 712	(302)999-3186
	Description of Equipment	Coextrusion cast line capable of 20 in wide film with 4 extruders							
	Cautions & Vendor Sensitivities								

PRE-TEST PLANNING SHEET

6/21/01

Test Title	Wraps Coextrusion Trials				
Date Planned	06/22/01	**Dates of Test**	7/5 and 7/6	**Location/Facility**	Chestnut Run Bldg 712
Overall Purpose of Test	Produce a film that would be acceptable to take to Carls Jr.				

Pre-Test Preparation Plan

Task	Who	By When	Comments
Inspection of Materials	J. Kelley	2-Jul	Make sure that if material has been sent to warehouse that it is called back for 10:00 am delivery on July 2
Test Preps to Vendor	JMS	26-Jun	
Test Plan to Vendor	JMS	26-Jun	

Detailed Description of Preparations Needed at Facility Before Test Begins

Must have:
1. Matte chill roll
2. Shear rate vs viscosity curves
3. 5 dryers
4. John Kelley present when dryers loaded on July 3
5. John Kelley and Kishan present at 7 am to supervise blending and loading of dryers
6. Nip roll in place

DETA.LED TEST PLANNING SI.EET

6/21/01

Test Title	Wraps Coextrusion Trials				
Date Planned	06/22/01	**Dates of Test**	7/5 and 7/6	**Location/Facility**	Chestnut Run Bldg 712
Overall Purpose of Test	Produce a film that would be acceptable to take to Carls Jr.				

Detailed Description of Test Itself:

Describe Task Order

(1) **30% A-Layer: 50% Eastar Bio/T-4338 + 30% Biomax 4026 + 20% Eastar Bio**
40% B-Layer: 77% Biomax/T-3818 + 23% Eastar Bio
30% C-Layer: 45% Eastar Bio/T-5346 + 25% Biomax 4026 + 30% Eastar Bio

(2) **50% A-Layer: 50% Eastar Bio/T-4338 + 25% Biomax 4026 + 25% Eastar Bio**
50% B-Layer: 77% Biomax/T-3818 + 23% Eastar Bio

(3) **50% A-Layer: 50% Eastar Bio/T-5346 + 25% Biomax 4026 + 25% Eastar Bio**
50% B-Layer: 77% Biomax/T-3818 + 23% Eastar Bio

NOTES: **1. If tear strength is very good, increase the %filler by 5% in the B-layers only. 2. If tear strength is poor, increase the %EastarBio by 5% in the A and C layers.**

outputs, ...ts to be		
	Start with #1 ABC	
	Determine processing temperatures (spend no more than 1 hour)	

DETAILED TEST PLANNING SHEET

6/21/01

Details of Each Task: Specify inputs and desired length of time expected to complete, measuremen taken.	collect 500 feet (10 minutes)			
	Test elmendorf tear in 713 lab (30 minutes)			
	Change feedblock (1 hour)			
	Run #2 AB (30 minutes to transition)			
	Determine processing temperatures (spend no more than 1 hour)			
	collect 500 feet (10 minutes)			
	Test elmendorf tear in 713 lab			
	Run #3 AB (30 minutes to transition)			
	Determine processing temperatures (spend no more than 1 hour)			
	collect 500 feet (10 minutes)			
	Test elmendorf tear in 713 lab			
	Repeat runs 1-3, if necessary, as per the above notes 1 and 2.			
Other Test Information				
Statistical Design of Test				
Work Planned vs. Facilities Capability	Total Time to Do All Planned Tasks	Total Time Available on Facility	Is There a 25% Time Safety Factor	Does the Test Plan Need to Be Modified?
	8 hours	20 hours	Yes, We can run overtime if we need to	See Notes 1 and 2

Interoffice Memorandum

To:	Kishan Khemani, Randy Smith, John Nevling
From:	Deni Miller
Date:	August 31, 2001
Subject:	FFU Wrap Comparison: Competitor Wraps and EarthShell MDO Monolayer
Cc:	Per Andersen, Patricia Fredlund, Amitabha Kumar
Keywords:	*Kitchen testing and results, FFU, burger test, moisture loss, meat temperature change, wraps, Carl's Jr., McDonald's, Wendy's, MDO monolayer, ABC 5-2, dead fold, puncture resistance, grease resistance, time in motion*

The Fitness for Use (FFU) of the EarthShell sandwich wrap MDO monolayer was compared to three competitor wraps currently being used: Carl's Jr. Wax Paper, McDonald's QPC Quilted Paper and Wendy's Foil. Data from the EarthShell ABC 5-2 wrap is also included. This report contains the results of the following FFU tests: physical dimensions, microwaveability and meat temperature/weight loss over ½ hour, grease resistance, burger test, puncture resistance, dead-fold and time in motion.

Results and Discussion

Physical Dimensions

The length, width, thickness and basis weight were measured on three wrap samples of each type of wrap. The results are shown in Table 1 and Figures 1-2. The EarthShell MDO monolayer wraps were cut to approximately the same size as the Carl's Jr. wraps, 13.0" x 14.25", and have a basis weight of 8.5 lb/1000 sq. ft which is similar to the Wendy's foil wrap. The Wendy's foil wraps are the smallest at 13" x 10.5" and the Carl's Jr. wax paper wrap are the lightest with a basis weight of 7.9 lb/1000 sq. ft.

Microwaveability and Meat Temperature/Weight Loss Over ½ Hour

A Carl's Jr. Famous Star™ with no lettuce or cheese (made at the restaurant, transported to the lab and cooled to approximately room temperature) is wrapped, microwaved for 10 seconds in the McDonald's Q-ing Oven and set on the table. The weight changes and meat temperatures of the wrapped sandwiches are measured at five-minute intervals for 20 minutes. Three sandwiches are tested in the EarthShell wrap and three in the Carl's Jr. wax paper wraps for comparison. Each wrap is weighed dry (before the test), with condensed moisture (after the test), and with absorbed moisture (after the test and after wiping out condensed moisture). Results are shown in Tables 2 and 3, and Figures 3-5.

The Carl's Jr. wax paper wrap absorbed almost twice the moisture the EarthShell MDO wrap absorbed and lost 85% more moisture through the wrap. Consequently, this led to 64% more moisture loss in the sandwiches wrapped in the Carl's Jr. wrap as compared to the EarthShell MDO wrap. The EarthShell

wrap had twice the condensate on the wrap interior than the Carl's Jr. wrap. Both wraps produced nearly the same loss in overall meat temperature of approximately 18°C in the 20 minute time period.

Grease Resistance

The Federal Grease test was performed on one of each of the five wraps tested. Both EarthShell wraps and the Wendy's foil wrap performed very well and had no penetration of the oil. The Carl's Jr. wax paper wrap and the McDonald's quilted wrap both had a very small amount of leak through. The Carl's Jr. wrap had eight grease spots of 1-3 mm in size (~ 27 mm^2 total) and the McDonald's quilted wrap had three grease spots all of approximately 3 mm in size (~ 21 mm^2 total).

Burger Test

A fresh Carl's Jr. Famous Star™ sandwich is placed in each of two wraps at the restaurant and placed in a bag together. The time is recorded on the bag and the top flap of the bag is rolled over to trap any heat and moisture that may escape the wraps. After 15 minutes, the bag is opened and the wrapped sandwiches are evaluated for sticking together, leakage, condensation, holding food together and grease show-through. After the 15 minute interval, the EarthShell wraps had a small amount of condensation on the inside of the wrap, however, the bun was not wet or soggy. There was no sticking between the two wrapped sandwiches and they held the sandwiches together well. There was also no leakage or grease show-through in either wrapped sandwich.

Puncture Resistance

The puncture resistance of five wrap samples was measured on the Instron using the testing fixture in Figure 6. Wrap samples were placed between the plates and loaded at 20 inches/minute until punctured. The maximum load and displacement at the maximum load was recorded. Table 4 includes the averages, standard deviations and minimum and maximum data. Figure 7 contains a plot of the maximum load and displacement. The average maximum load of the EarthShell MDO wrap is 1.23 ± 0.07 lb_f and the average maximum displacement is 0.40″ ± 0.02″. The McDonald's quilted wrap had the highest maximum load at 1.90 lb_f.

Dead Fold

A 50 gram weight is placed on a bent over strip of wrap (1″ x 4″) for 10 seconds. Thirty seconds after the weight is removed, the angle formed by the crease is read with a protractor. Twelve readings are taken on each of six samples cut in both the machine direction and the cross direction for a total of 24 data points for each wrap. The average percentage crease retained (C) in each direction is then calculated from C = 100*(180-A)/180 where A is the average angle formed in the crease. The raw data is reported in Table 5 and a summary of the data in Table 6. Figures 8-9 contain plots of the crease retention in both the machine and cross direction and Figure 10 shows the average crease retention. The EarthShell MDO wrap far exceeded any of the other wraps with 100% crease retention. The Wendy's foil wrap was the next closest with 77% crease retention.

Time in Motion

The time in motion test measures the time required to transfer one sandwich wrap from a wrap tree to the food preparation area and lay in a perfectly flat position. The wrap tree is 18″ above the food preparation area. Twenty wraps were transferred one at a time; the time was measured for each

individual transfer and averaged. The raw data is reported in Table 7 and a plot of the average time in motion with the standard deviation is in Figure 11. The average time in motion for the EarthShell MDO wrap was slightly better than the EarthShell ABC 5-2 wrap, 1.9 ± 0.8 seconds as compared to 2.2 ± 0.8 seconds, respectively. The Wendy's foil wrap had the lowest time in motion at 1.1 ± 0.4 seconds. Also note that both the EarthShell wraps had almost twice the standard deviation than the three competitor wraps tested.

Table 1. Physical Dimensions

Wrap	Size (L x W)	Area (sq. inches)	Thickness (inches)	Basis Weight (lb./1000 sq. ft.)
Carl's Jr. Wax Paper	13.0" x 14.25"	185.25	0.0020	7.9
McDonald's QPC Quilted	13.0" x 11.5"	149.50	0.0035	9.2
Wendy's Foil	13.0" x 10.5"	136.50	0.0015	8.6
EarthShell ABC 5-2	15.0" x 15.0"	225.00	0.0016	9.8
EarthShell MDO	~ 13.0" x 14.25"	185.25	0.0030	8.5

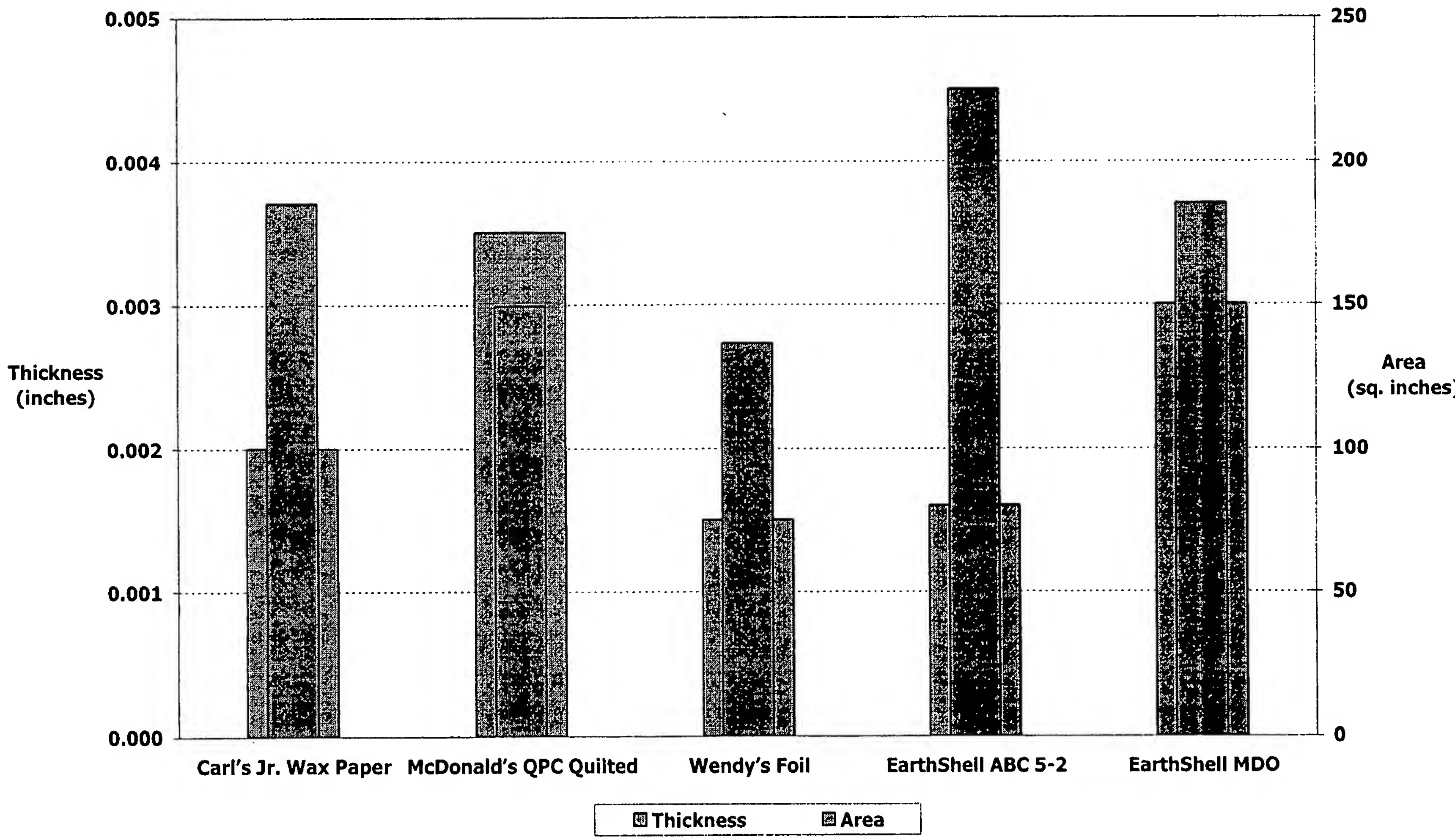


Figure 1. Thickness and Area Measurements of EarthShell and Competitor Wraps

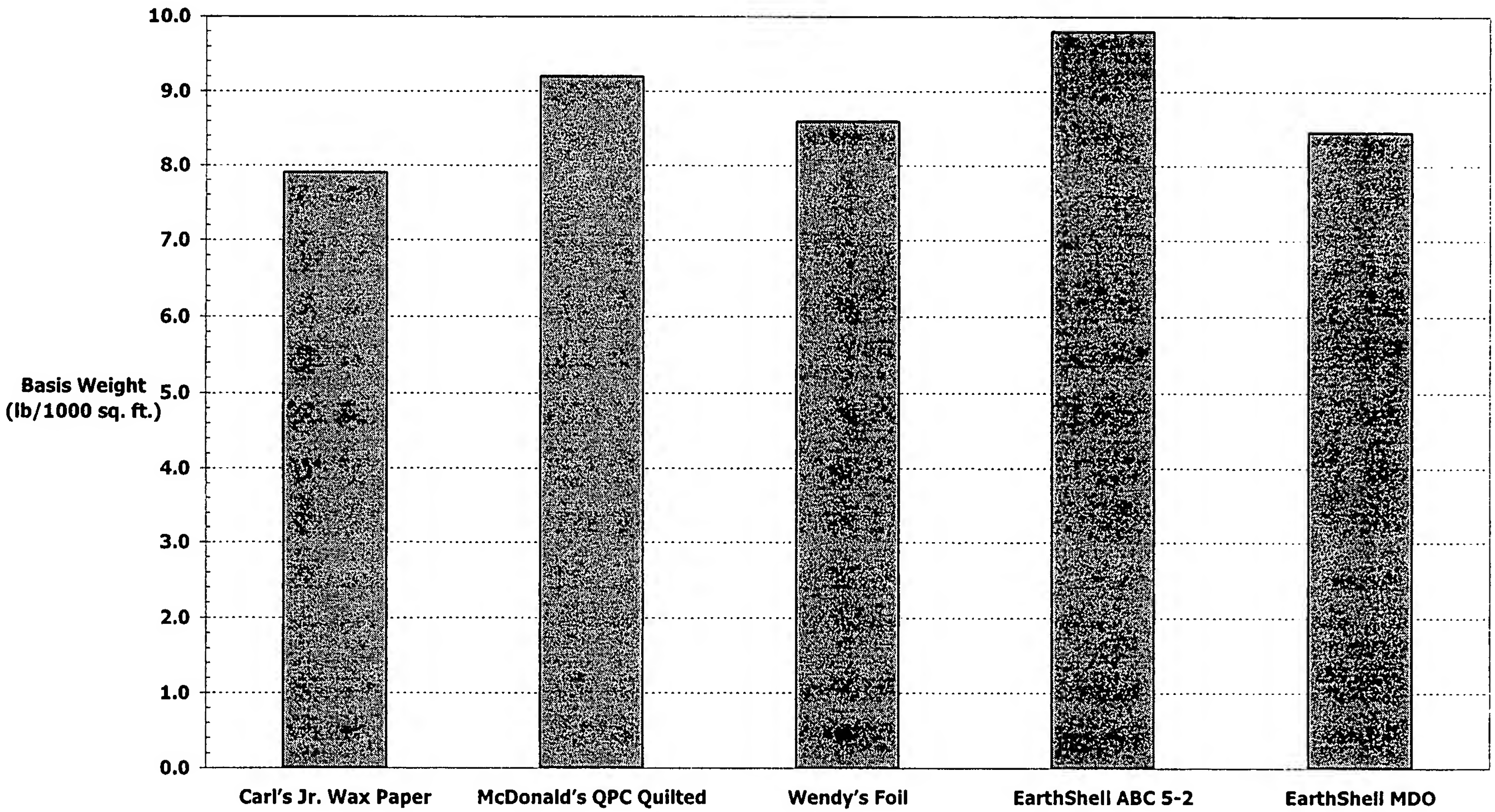


Figure 2. Basis Weight of EarthShell and Competitor Wraps

Table 2. Average Weight and Temperature Measurements

Wrap Description	Averages for 8-28-01								Averages for 8-28-01			
	Wrap weight			Package (wrap + sandwich) weight and max. temp.								
	Wrap wt. before test	Wrap wt. change after test	Wrap wt. change after wiping	0 min	5 min	10 min	20 min		Moisture absorbed by wrap	Condensed + absorbed moisture	Moisture lost through wrap	Moisture lost by sandwich
3 Carl's Jr. Wax Paper Wrap	4.6	0.5	0.4	0.0	-0.4	-0.7	-1.2	wt. (g)	0.41	0.53	1.24	1.77
				0.0	5.0	10.0	20.0	elapsed time (min)				
				62.1	55.9	50.6	44.6	temp (°C)				
				0.0	-6.3	-11.6	-17.6	temp change (°C)				
3 MDO Monolayer Wraps	5.0	0.4	0.2	0.0	-0.1	-0.1	-0.2	wt. (g)	0.19	0.45	0.19	0.64
				0.0	5.0	10.0	20.1	elapsed time (min)				
				63.7	57.9	52.3	45.2	temp (°C)				
				0.0	-5.7	-11.3	-18.5	temp change (°C)				

Table 3. Average Moisture Distributions

	Moisture Distribution After Test			
	Moisture condensed on wrap interior (g)	Moisture absorbed by wrap (g)	Moisture lost to atmosphere (g)	Total moisture lost by sandwich (g)
3 Carl's Jr. Wax Paper Wrap	0.12	0.41	1.24	1.77
3 MDO Monolayer Wraps	0.25	0.19	0.19	0.64

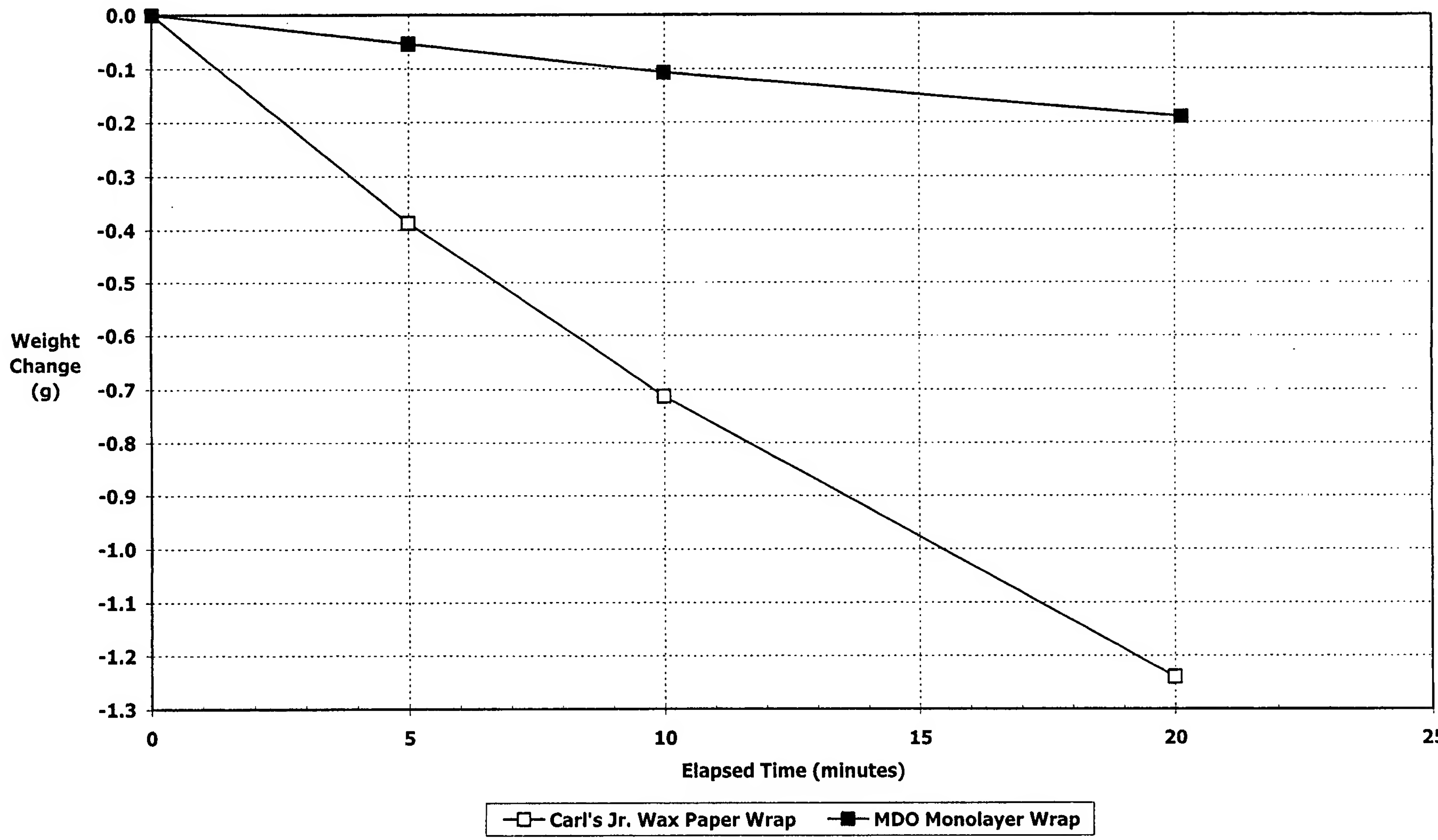


Figure 3. Change in Package Weight with Time for Wrapped Carl's Jr. Sandwiches in EarthShell and Competitor Wraps

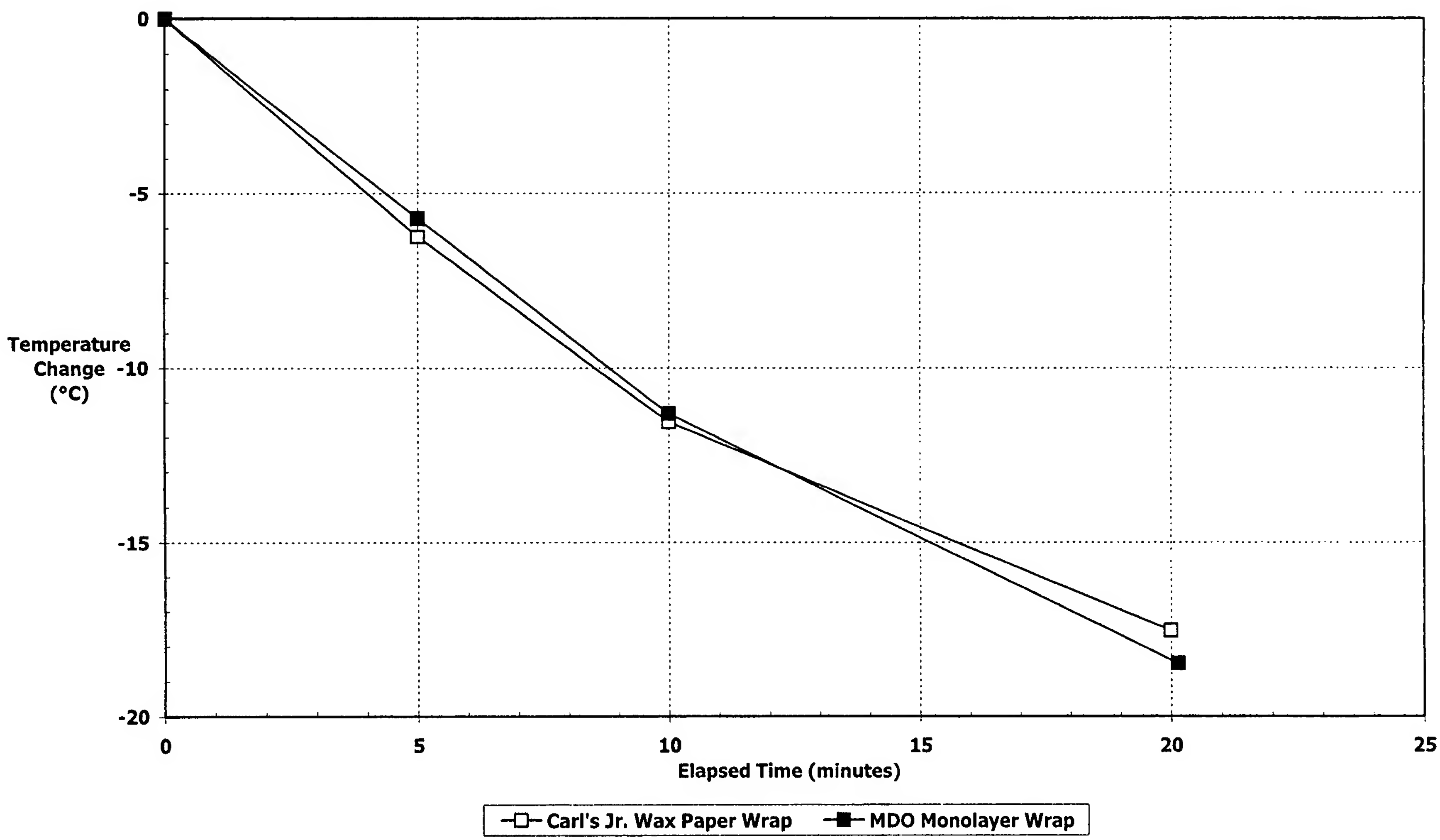


Figure 4. Change in Meat Temperature with Time for Wrapped Carl's Jr. Sandwiches in EarthShell and Competitor Wraps

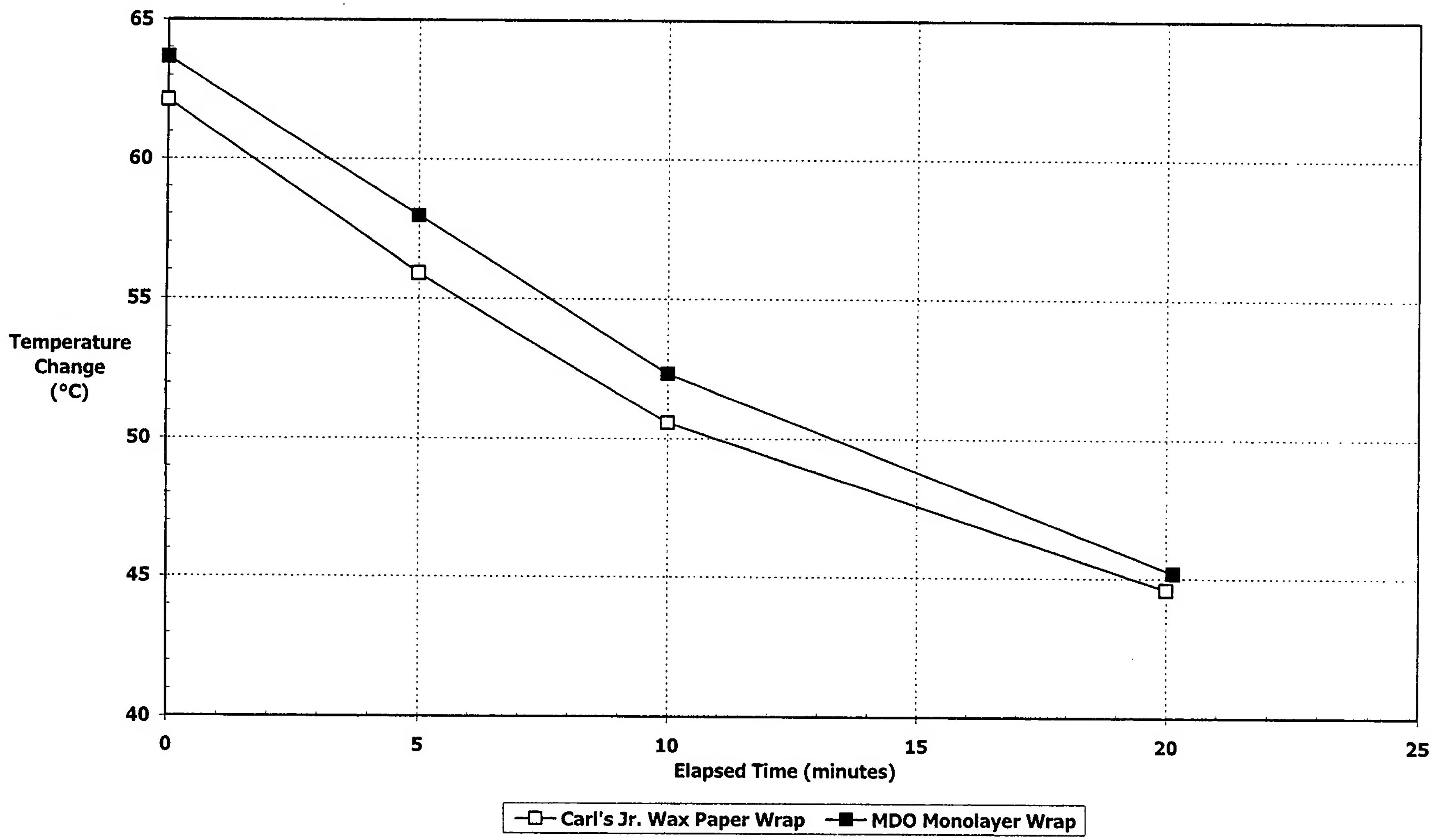


Figure 5. Variation in Temperature with Time for Wrapped Carl's Jr. Sandwiches in EarthShell and Competitor Wraps

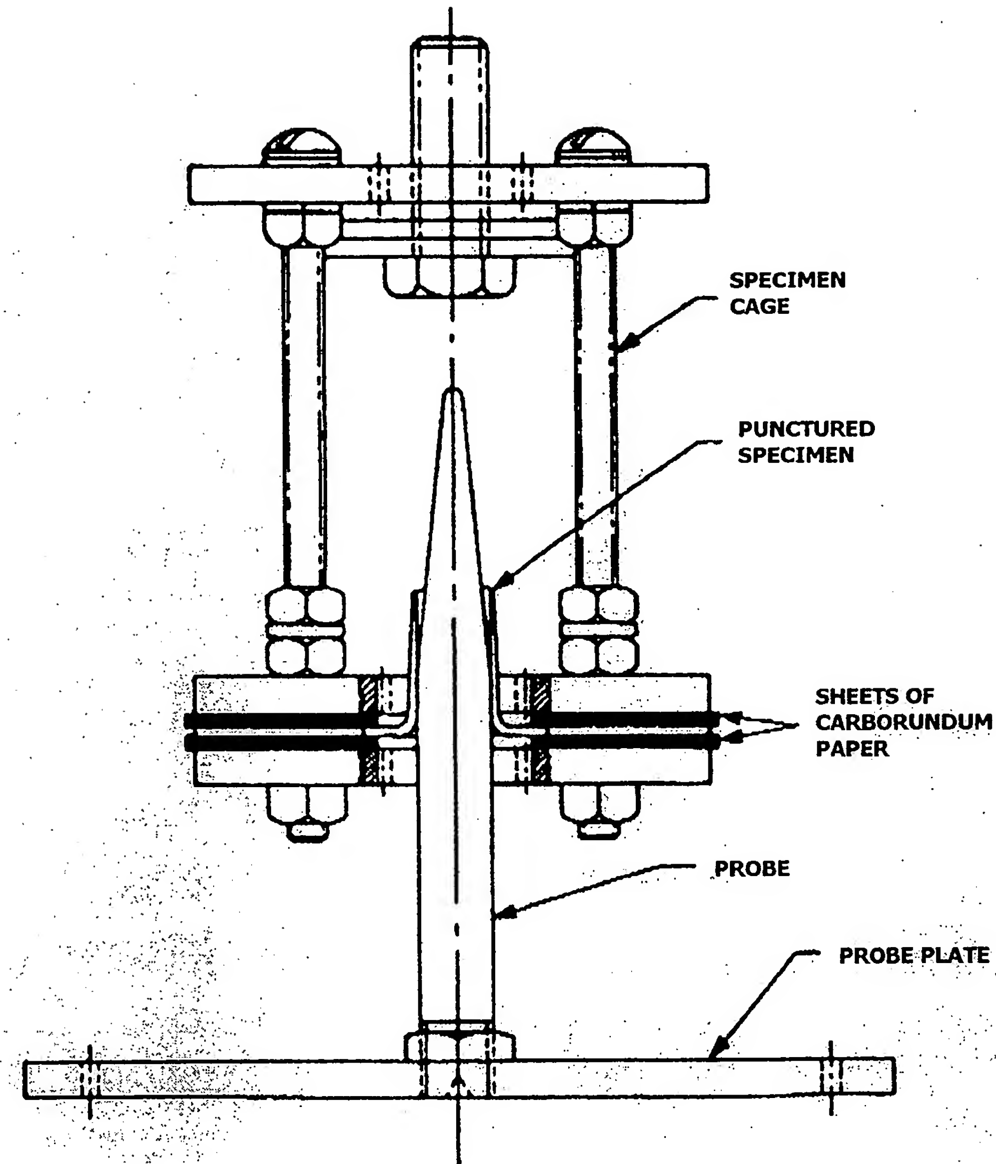


Figure 6. Puncture Resistance Test Fixture – Side View

Table 4. Puncture Resistance Data

Puncture Resistance - Average Data

Wrap	Max. Load (lb_f)	Displacement at Max Load (in.)
Carl's Jr. Wax Paper	1.25 ± 0.67	0.17 ± 0.04
McDonald's QPC Quilted	1.90 ± 0.18	0.10 ± 0.01
Wendy's Foil	1.83 ± 0.70	0.11 ± 0.02
EarthShell ABC 5-2	1.19 ± 0.04	0.29 ± 0.05
EarthShell MDO	1.23 ± 0.07	0.40 ± 0.02

Puncture Resistance - Minimum & Maximum Data

Wrap	Max. Load (lb_f)	Displacement at Max Load (in.)
Carl's Jr. Wax Paper	0.61 to 2.15	0.12 to 0.22
McDonald's QPC Quilted	1.72 to 2.11	0.09 to 0.12
Wendy's Foil	1.08 to 2.94	0.10 to 0.15
EarthShell ABC 5-2	1.15 to 1.25	0.24 to 0.36
EarthShell MDO	1.12 to 1.29	0.36 to 0.42

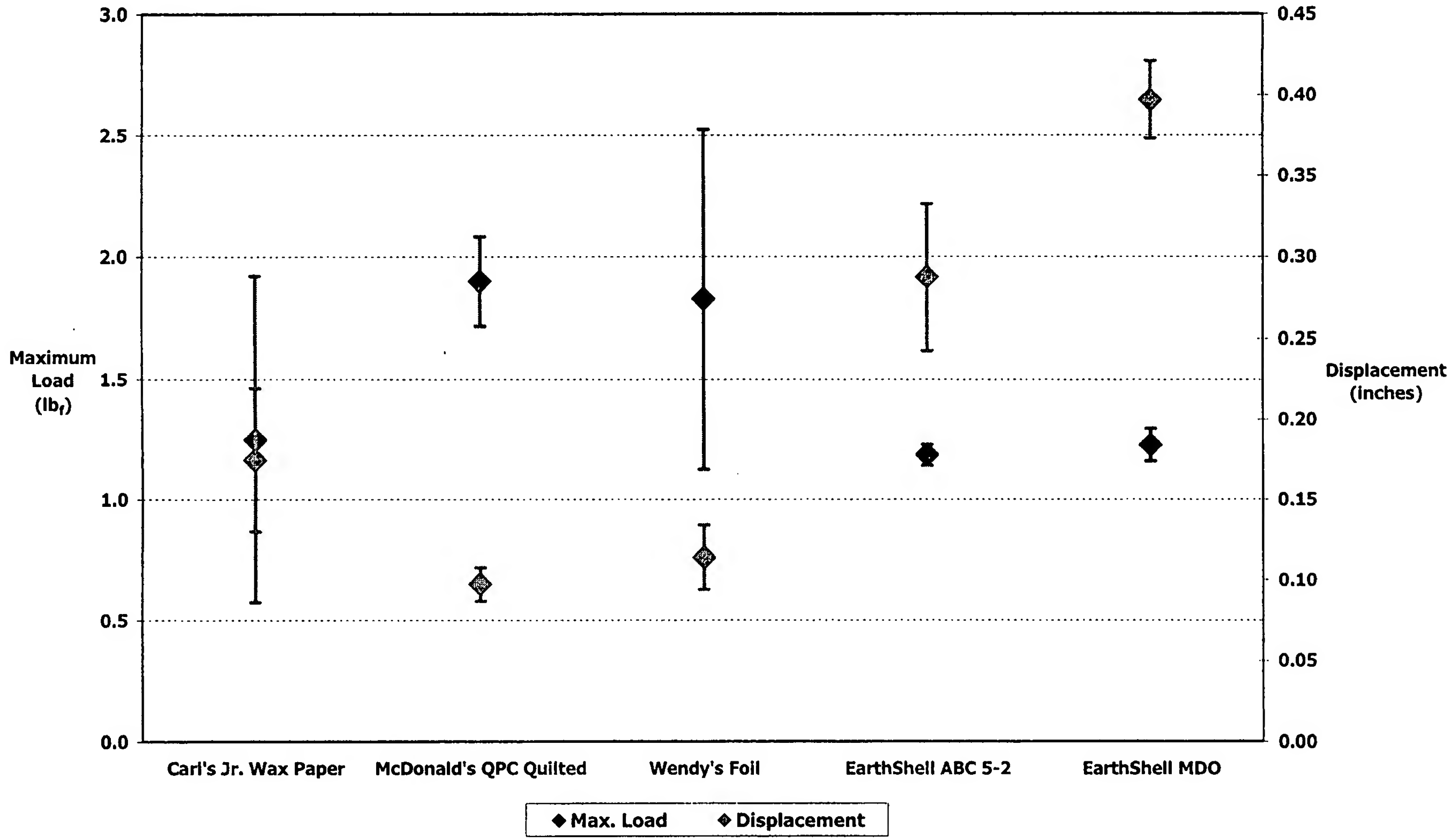


Figure 7. Puncture Resistance Maximum Load and Displacement in EarthShell and Competitor Wraps

Table 5. Dead Fold Raw Data

Direction 1 (machine)	Carl's Jr. Wax Paper	McDonald's QPC Quilted	Wendy's Foil	EarthShell ABC 5-2	EarthShell MDO
Specimen 1	80	90	50	115	0
	80	70	15	118	0
Specimen 2	70	80	50	147	0
	70	90	30	125	0
Specimen 3	80	90	60	73	0
	25	110	40	75	0
Specimen 4	60	100	50	74	0
	80	85	40	100	0
Specimen 5	60	110	20	21	0
	70	90	70	88	0
Specimen 6	80	90	60	80	0
	75	100	20	62	0
Average Angle	69.2	92.1	42.1	89.8	0.0
Crease Retained	62%	49%	77%	50%	100%

Direction 2 (cross)	Carl's Jr. Wax Paper	McDonald's QPC Quilted	Wendy's Foil	EarthShell ABC 5-2	EarthShell MDO
Specimen 1	75	115	40	94	0
	80	100	70	30	0
Specimen 2	70	90	40	108	0
	80	120	25	135	0
Specimen 3	65	120	55	15	0
	80	100	40	0	0
Specimen 4	70	110	50	70	0
	65	125	20	80	0
Specimen 5	70	130	20	145	0
	80	110	30	63	0
Specimen 6	60	120	70	73	0
	70	130	35	112	0
Average Angle	72.1	114.2	41.3	77.1	0.0
Crease Retained	60%	37%	77%	57%	100%

Table 6. Dead Fold Summary

Wrap	Direction 1 (machine)	Direction 2 (cross)	Average
Carl's Jr. Wax Paper	62% ± 9%	60% ± 4%	61% ± 7%
McDonald's QPC Quilted	49% ± 6%	37% ± 7%	43% ± 9%
Wendy's Foil	77% ± 10%	77% ± 10%	77% ± 10%
EarthShell ABC 5-2	50% ± 19%	57% ± 25%	54% ± 22%
EarthShell MDO	100% ± 0%	100% ± 0%	100% ± 0%

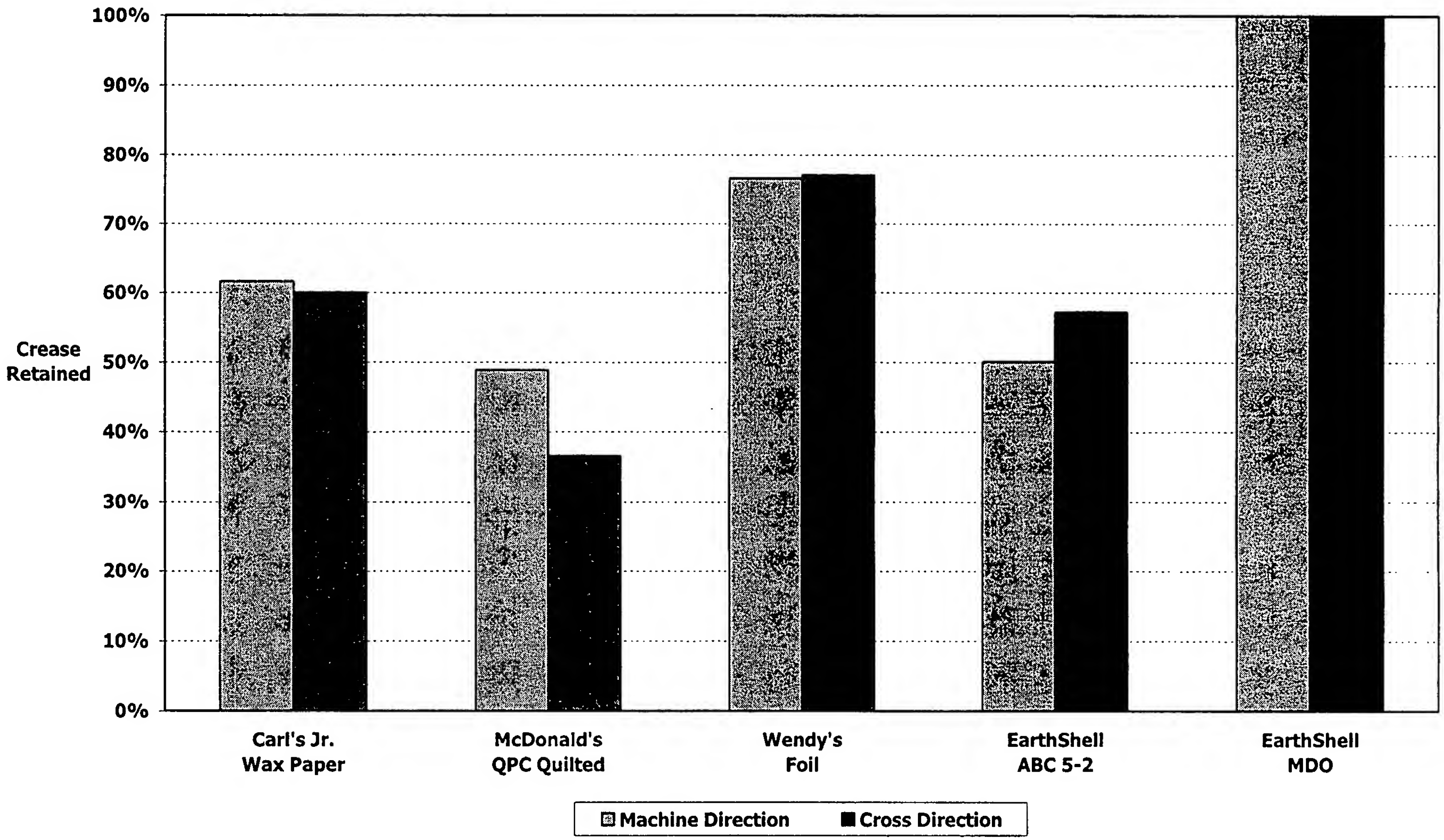


Figure 8. Crease Retention in EarthShell and Competitor Wraps

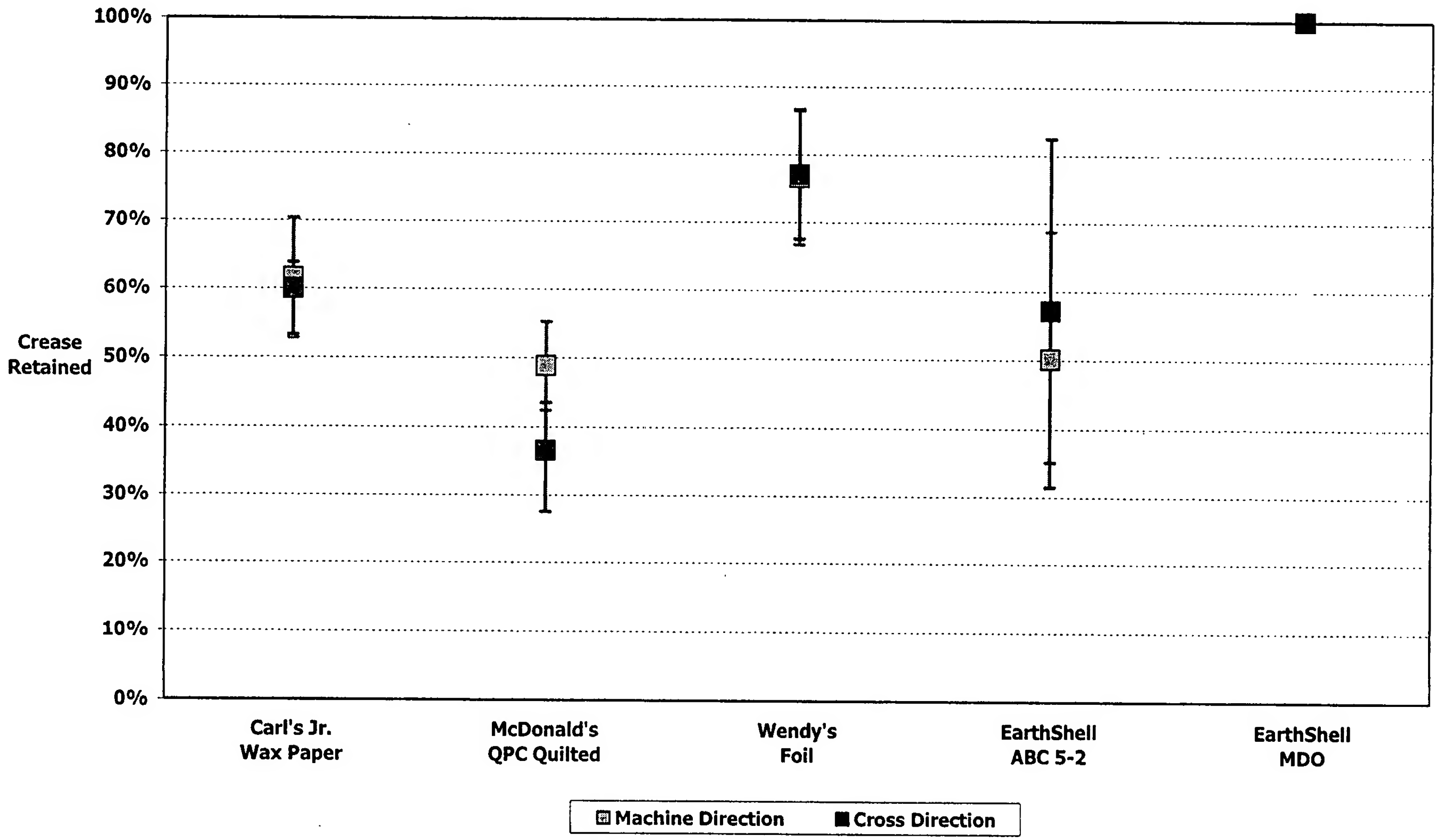


Figure 9. Crease Retention with Standard Deviations in EarthShell and Competitor Wraps

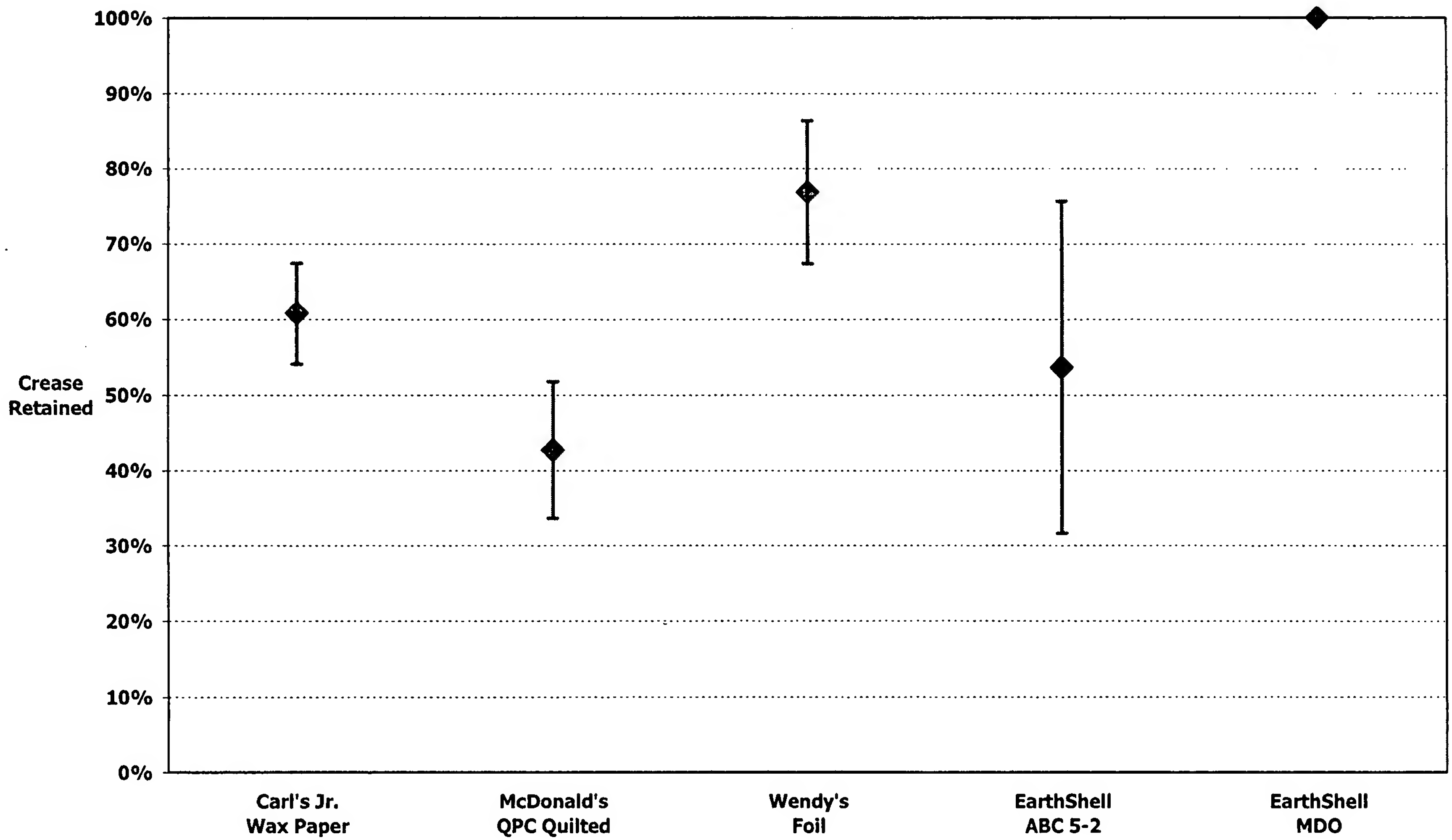


Figure 10. Average Crease Retention in EarthShell and Competitor Wraps

Table 7. Time in Motion Raw Data and Averages

Sample	Carl's Jr. Wax Paper (seconds)	McDonald's QPC Quilted (seconds)	Wendy's Foil (seconds)	EarthShell ABC 5-2 (seconds)	EarthShell MDO (seconds)
1	1.26	0.98	0.89	1.96	1.82
2	1.14	0.42	0.90	1.97	4.17
3	0.91	0.58	1.15	2.17	2.80
4	1.29	1.86	1.63	2.14	2.89
5	1.37	1.67	1.00	1.79	1.76
6	1.03	1.28	0.86	2.02	1.80
7	2.12	1.55	1.11	2.40	1.95
8	1.61	0.90	1.07	1.76	1.06
9	1.57	1.08	1.94	1.80	1.42
10	1.74	2.25	1.35	1.63	1.67
11	1.15	1.21	1.06	2.22	1.26
12	0.85	2.11	1.03	4.09	1.49
13	2.10	1.48	1.11	2.91	1.84
14	1.44	1.53	0.58	2.74	1.23
15	2.41	0.98	0.73	2.48	1.50
16	1.25	1.48	0.46	1.74	1.17
17	0.91	1.00	0.66	1.71	1.77
18	1.41	1.87	2.01	3.90	2.28
19	1.15	1.17	1.25	1.56	1.51
20	0.64	1.25	1.26	0.80	2.83
Average	1.37	1.33	1.10	2.19	1.91
St. Dev.	0.46	0.48	0.40	0.77	0.76
Minimum	0.64	0.42	0.46	0.80	1.06
Maximum	2.41	2.25	2.01	4.09	4.17

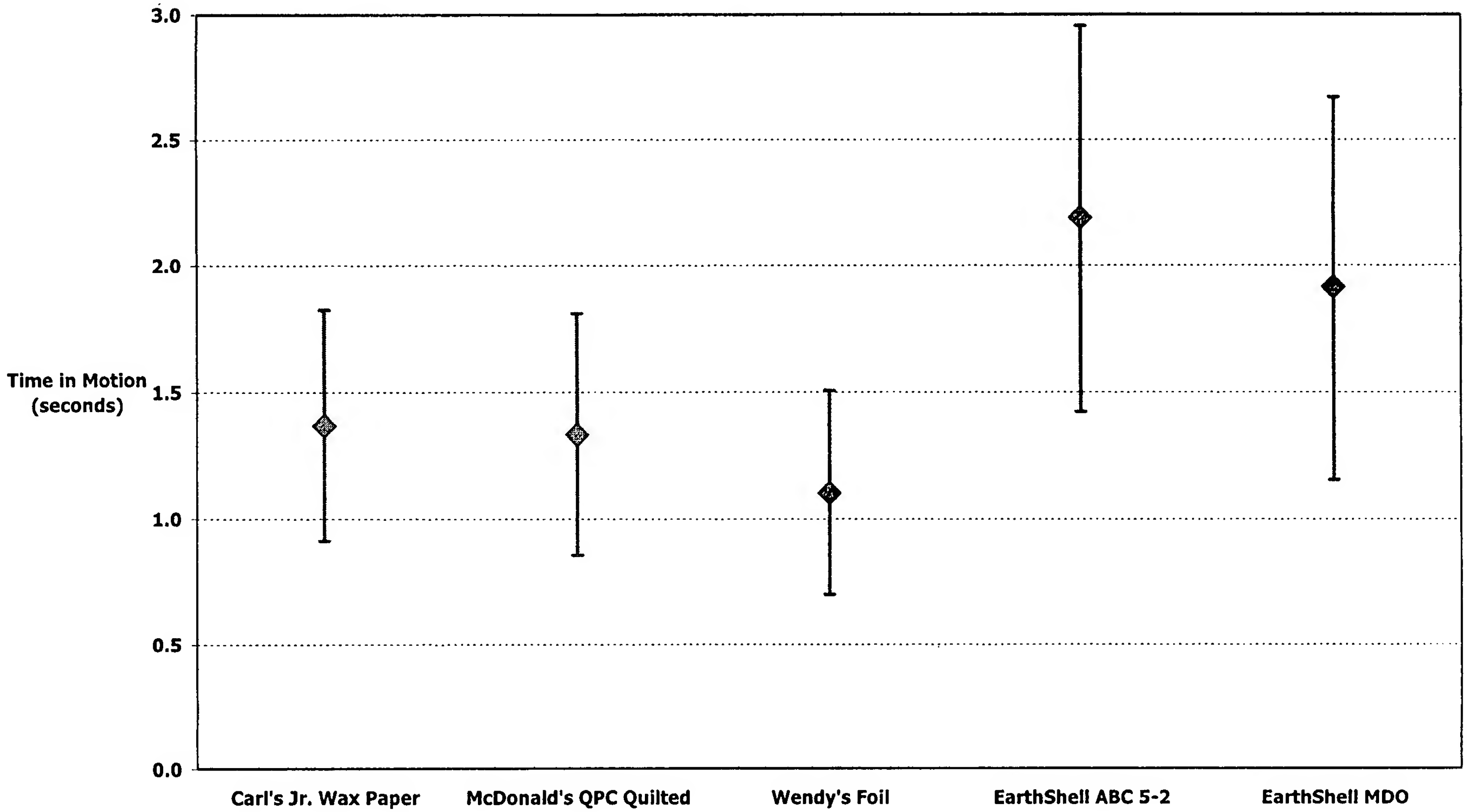


Figure 11. Time in Motion of EarthShell and Competitor Wraps

EarthShell CORPORATION

Interoffice Memorandum

To:	Kishan Khemani
From:	Deni Miller
Date:	September 18, 2001
Subject:	Tear Resistance of Sandwich Wraps
Cc:	Per Andersen, Patricia Fredlund, Amitabha Kumar, Randy Smith
Keywords:	*tear resistance, wraps, Carl's Jr., ABC 5-2, monolayer, AB 6-4, MDO*

A tear resistance test was performed on four EarthShell wraps and the Carl's Jr. wax paper wrap. The EarthShell wraps tested were the ABC 5-2, AB 6-4, the printed monolayer and the MDO monolayer.

The tear resistance of the wraps is measured with the initial tear resistance test of plastic film (ASTM D 1004). Using a die, four-inch long specimens are stamped out and placed in grips that are one inch apart. A tearing rate of 2"/minute is used and the maximum force to tear the specimen is recorded. Three specimens from both the machine and cross directions of each wrap were tested and averaged. All specimens were tested after conditioning at 23°C and 50% RH for 40 hours.

The Carl's Jr. wrap has the highest tear resistance of the wraps tested, 4.13 Newtons. The EarthShell wrap with the highest tear resistance is the ABC 5-2 at 3.09 Newtons, and very close behind is the printed monolayer wrap at 2.96 Newtons. The lowest tear resistance was in the AB 6-4 wrap at 1.47 Newtons. Table 1 contains a summary of the data and the average tear resistance is plotted in Figure 1.

Table 1. Data Summary

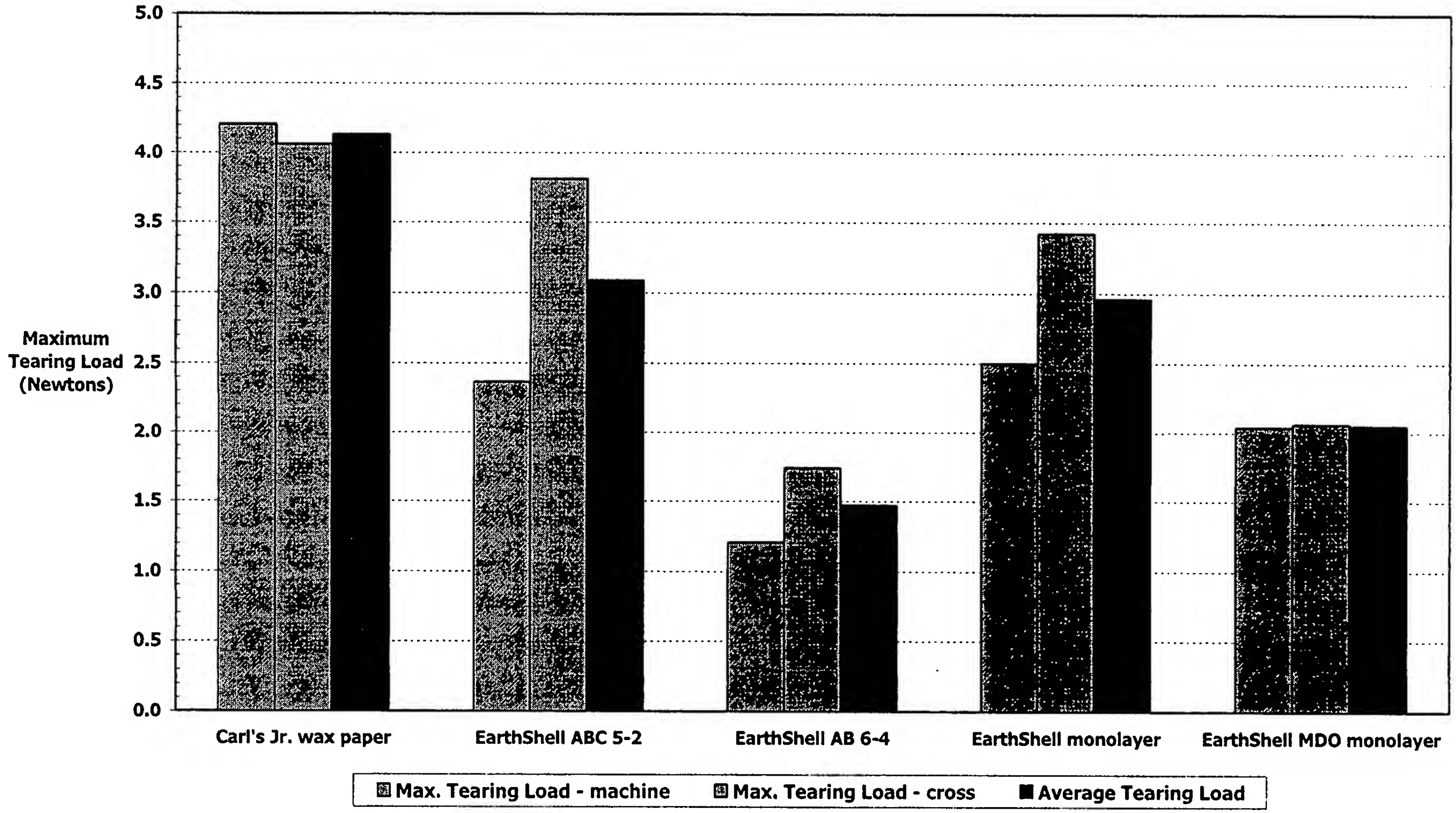
Average Data

Wrap	Max. Tearing Load - machine (Newtons)	Max. Tearing Load - cross (Newtons)	Average Tearing Load (Newtons)
Carl's Jr. wax paper	4.21 ± 1.00	4.06 ± 0.99	4.13
EarthShell ABC 5-2	2.36 ± 0.29	3.81 ± 0.04	3.09
EarthShell AB 6-4	1.20 ± 0.06	1.74 ± 0.54	1.47
EarthShell monolayer	2.50 ± 0.07	3.42 ± 0.11	2.96
EarthShell MDO monolayer	2.04 ± 0.10	2.06 ± 0.29	2.05

Minimum & Maximum Data

Wrap	Tearing Load - machine (Newtons)	Tearing Load - cross (Newtons)	Average Tearing Load (Newtons)
Carl's Jr. wax paper	3.08 to 4.97	3.46 to 5.21	3.08 to 5.21
EarthShell ABC 5-2	2.13 to 2.69	3.78 to 3.85	2.13 to 3.85
EarthShell AB 6-4	1.16 to 1.26	1.17 to 2.25	1.16 to 2.25
EarthShell monolayer	2.41 to 2.56	3.33 to 3.55	2.41 to 3.55
EarthShell MDO monolayer	1.93 to 2.12	1.73 to 2.27	1.73 to 2.27

Figure 1. Maximum Tearing Load Comparison in Wraps



EarthShell CORPORATION

Interoffice Memorandum

To: John Nevling, Kishan Khemani, Randy Smith

From: Deni Miller

Date: August 24, 2001

Subject: Time in Motion Testing on EarthShell and Competitor Wraps

Cc: Per Andersen, Patricia Fredlund, Amitabha Kumar, Donna Balinke

Keywords: *FFU, time in motion, wraps, Carl's Jr., Wendy's, McDonald's quilted, ABC 5-2*

The time in motion test was performed on two different EarthShell wraps and various competitor wraps from Carl's Jr., McDonald's and Wendy's. The wraps were tested both as received (their normal sizes) and cut to the same size.

The time in motion test measures the time required to transfer one sandwich wrap from a wrap tree to the food preparation area and lay in a perfectly flat position. The wrap tree is 18" above the food preparation area. Twenty wraps are transferred one at a time; the time is measured for each individual transfer and averaged. The following table includes the wraps tested and their sizes:

Wrap	Size (L x W)	Area (sq. inches)	Thickness (inches)	Basis Weight (lb./1000 sq. ft.)
Carl's Jr. Wax Paper	13.0" x 14.25"	185.25	0.0020	7.9
McDonald's QPC Quilted	13.0" x 11.5"	149.50	0.0035	9.2
Wendy's Foil	13.0" x 10.5"	136.50	0.0015	8.6
EarthShell ABC 5-2	15.0" x 15.0"	225.00	0.0016	9.8
EarthShell monolayer printed	15.0" x 15.0"	225.00	0.0025	7.8

For the same size wrap test, the wraps were all cut to the size of the Wendy's foil wrap, 13.0" x 10.5". The EarthShell ABC 5-2 wrap was not available in the 13.0" x 10.5" size so the EarthShell monolayer 4338 printed wrap was cut to size as an alternative.

The raw data is reported in Tables 1-2 and is plotted in Figures 1-3. The data indicates that the time in motion is not affected by the size of the wrap. The EarthShell wraps have higher standard deviations than the competitor wraps and, on the average, have approximately one second higher time in motion.

Table 1. Time in Motion Raw Data – As Received Wraps

Sample	Carl's Jr. Wax Paper (seconds)	McDonald's QPC Quilted (seconds)	Wendy's Foil (seconds)	EarthShell ABC 5-2 (seconds)
1	1.26	0.98	0.89	1.96
2	1.14	0.42	0.90	1.97
3	0.91	0.58	1.15	2.17
4	1.29	1.86	1.63	2.14
5	1.37	1.67	1.00	1.79
6	1.03	1.28	0.86	2.02
7	2.12	1.55	1.11	2.40
8	1.61	0.90	1.07	1.76
9	1.57	1.08	1.94	1.80
10	1.74	2.25	1.35	1.63
11	1.15	1.21	1.06	2.22
12	0.85	2.11	1.03	4.09
13	2.10	1.48	1.11	2.91
14	1.44	1.53	0.58	2.74
15	2.41	0.98	0.73	2.48
16	1.25	1.48	0.46	1.74
17	0.91	1.00	0.66	1.71
18	1.41	1.87	2.01	3.90
19	1.15	1.17	1.25	1.56
20	0.64	1.25	1.26	0.80
Average	1.37	1.33	1.10	2.19
St. Dev.	0.46	0.48	0.40	0.77
Minimum	0.64	0.42	0.46	0.80
Maximum	2.41	2.25	2.01	4.09

Table 2. Time in Motion Raw Data – Same Size Wraps

Sample	Carl's Jr Wax Paper (seconds)	McDonald's QPC Quilted (seconds)	Wendy's Foil (seconds)	ES monolayer 4338 printed (seconds)
1	0.80	0.77	1.19	2.21
2	0.97	1.11	1.39	2.02
3	1.12	1.21	1.00	3.25
4	1.31	1.68	1.26	1.58
5	1.77	1.42	1.33	1.95
6	1.67	1.25	1.42	1.50
7	1.59	1.27	1.27	1.34
8	1.64	1.08	1.58	2.21
9	0.96	0.96	0.76	1.68
10	0.74	1.00	1.15	1.96
11	1.43	1.20	1.38	1.99
12	1.39	0.82	1.57	1.75
13	1.28	1.39	1.92	3.55
14	0.68	1.44	1.43	2.09
15	1.07	1.40	1.50	1.78
16	1.33	0.99	0.89	1.62
17	1.90	0.91	1.40	1.95
18	1.59	0.80	0.76	5.93
19	1.01	1.22	1.21	1.00
20	0.55	1.23	1.22	1.62
Average	1.24	1.16	1.28	2.15
St. Dev.	0.39	0.24	0.28	1.06
Minimum	0.55	0.77	0.76	1.00
Maximum	1.90	1.68	1.92	5.93

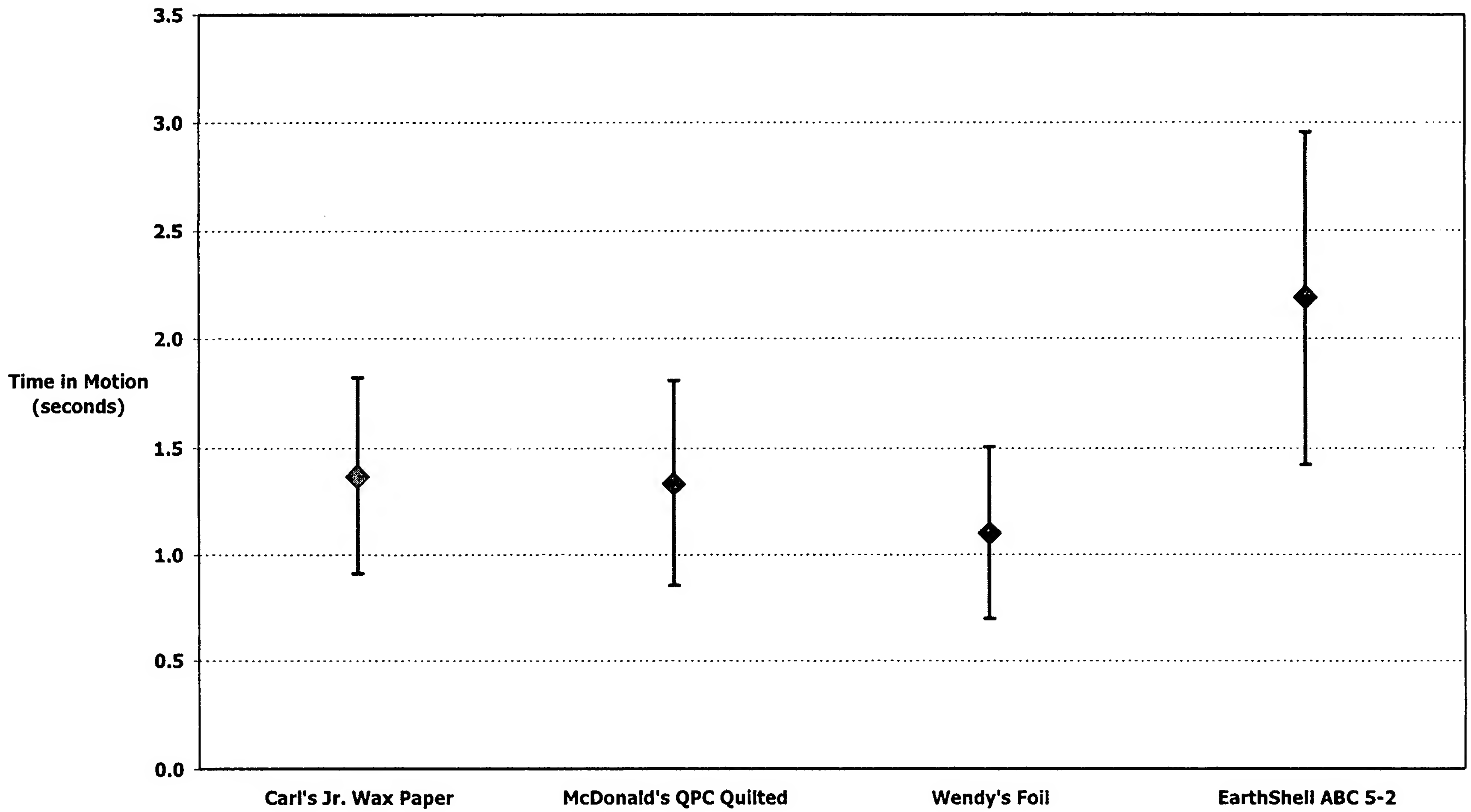


Figure 1. Time in Motion of EarthShell and Competitor Wraps As Received

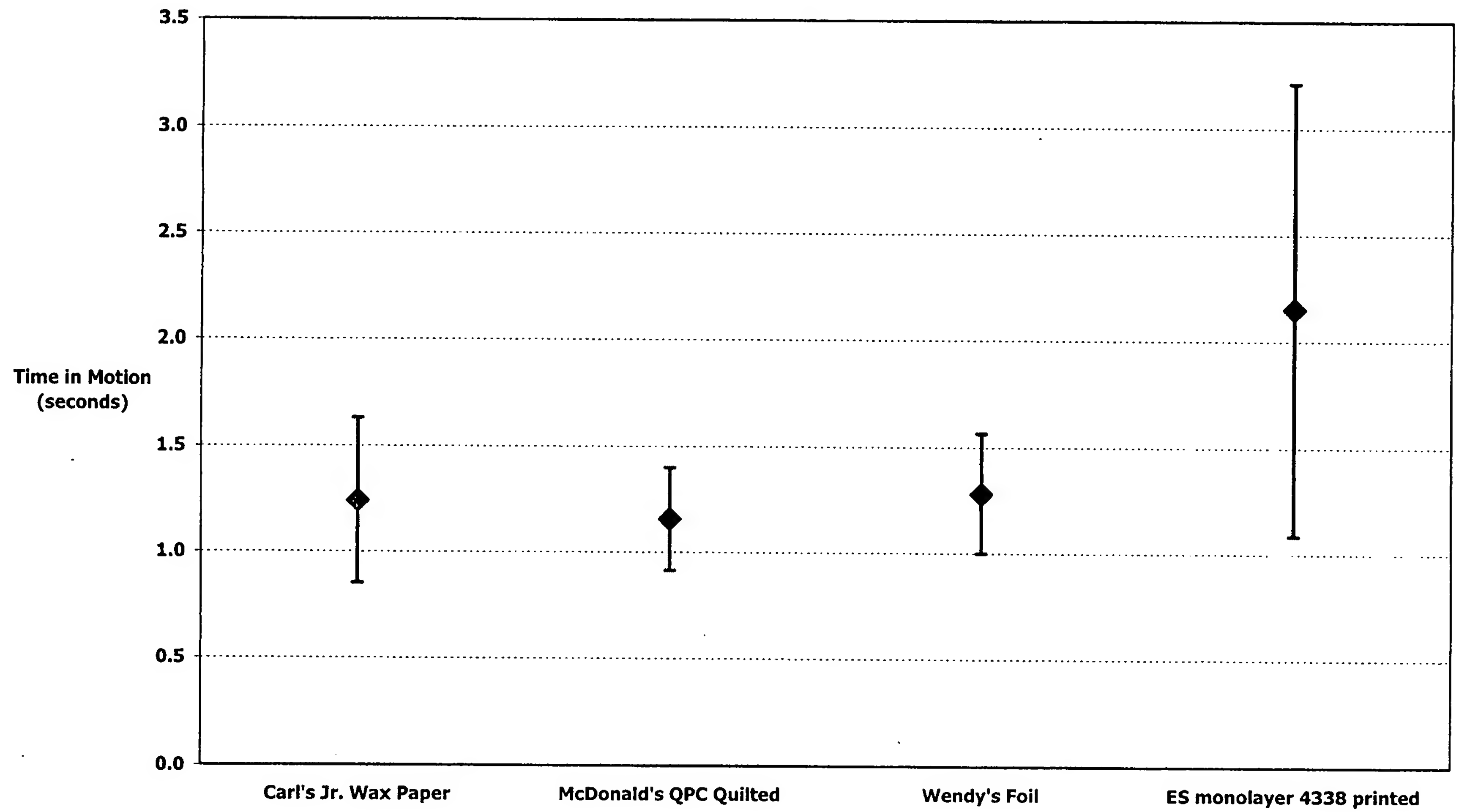


Figure 2. Time in Motion of EarthShell and Competitor Wraps Same Size

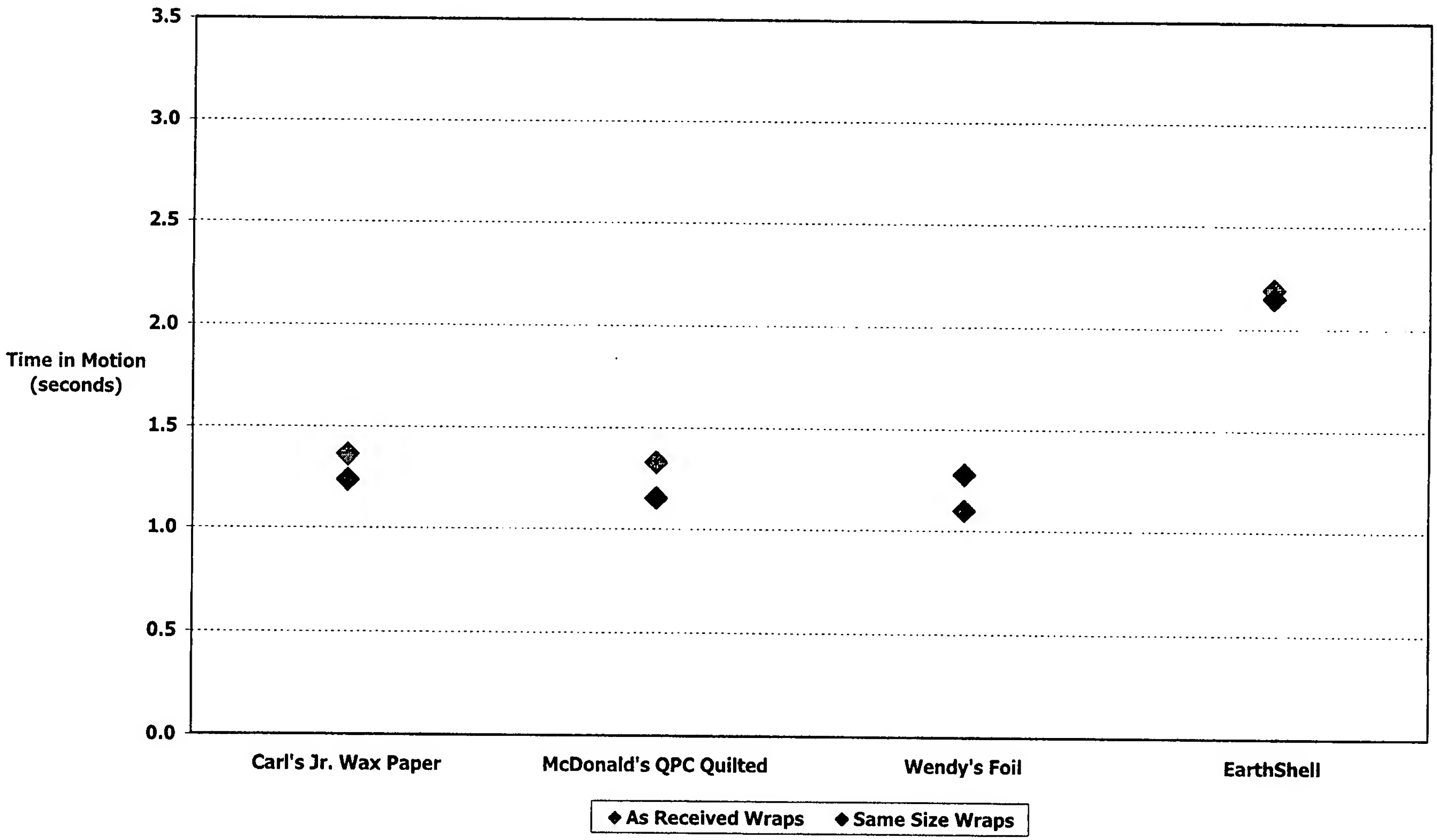


Figure 3. Time in Motion of EarthShell and Competitor Wraps

EarthShell CORPORATION

Interoffice Memorandum

To: Kishan Khemani

From: Deni Miller

Date: September 21, 2001

Subject: Mechanical Properties of Printed Monolayer and MDO Monolayer Sandwich Wraps

Cc: Patricia Fredlund, Per Andersen, Amitabha Kumar, Randy Smith

Keywords: *mechanical properties, wrap, monolayer, MDO*

The mechanical properties of two monolayer sandwich wraps were determined at low and high strain rates. The results of the tensile tests at strain rates of 200 and 1000 mm/minute and the elongation at a strain rate of 10 mm/minute are contained in Table 1. Figures 1-3 compare the peak stress, peak strain and modulus for the different strain rates and testing directions.

Table 1. Tensile Test Results at Low and High Strain Rates

Machine Direction

Wrap	Strain Rate (mm/min)	Peak Stress (MPa)	Peak Strain (%)	Modulus[2] (MPa)
Printed monolayer[1]	200	17 ± 1	1234 ± 30	625 ± 49
MDO monolayer	200	12 ± 1	415 ± 4	646 ± 75
Printed monolayer	1000	17 ± 0	1162 ± 58	
MDO monolayer	1000	14 ± 1	434 ± 105	

Cross Direction

Construction	Strain Rate (mm/min)	Peak Stress (MPa)	Peak Strain (%)	Modulus[2] (MPa)
Printed monolayer	200	9 ± 0	156 ± 58	534 ± 61
MDO monolayer	200	9 ± 1	27 ± 10	677 ± 149
Printed monolayer	1000	11 ± 1	50 ± 8	
MDO monolayer	1000	9 ± 2	22 ± 2	

[1] Two out of three samples did not break.

[2] Separate test with a strain rate of 10 mm/minute.

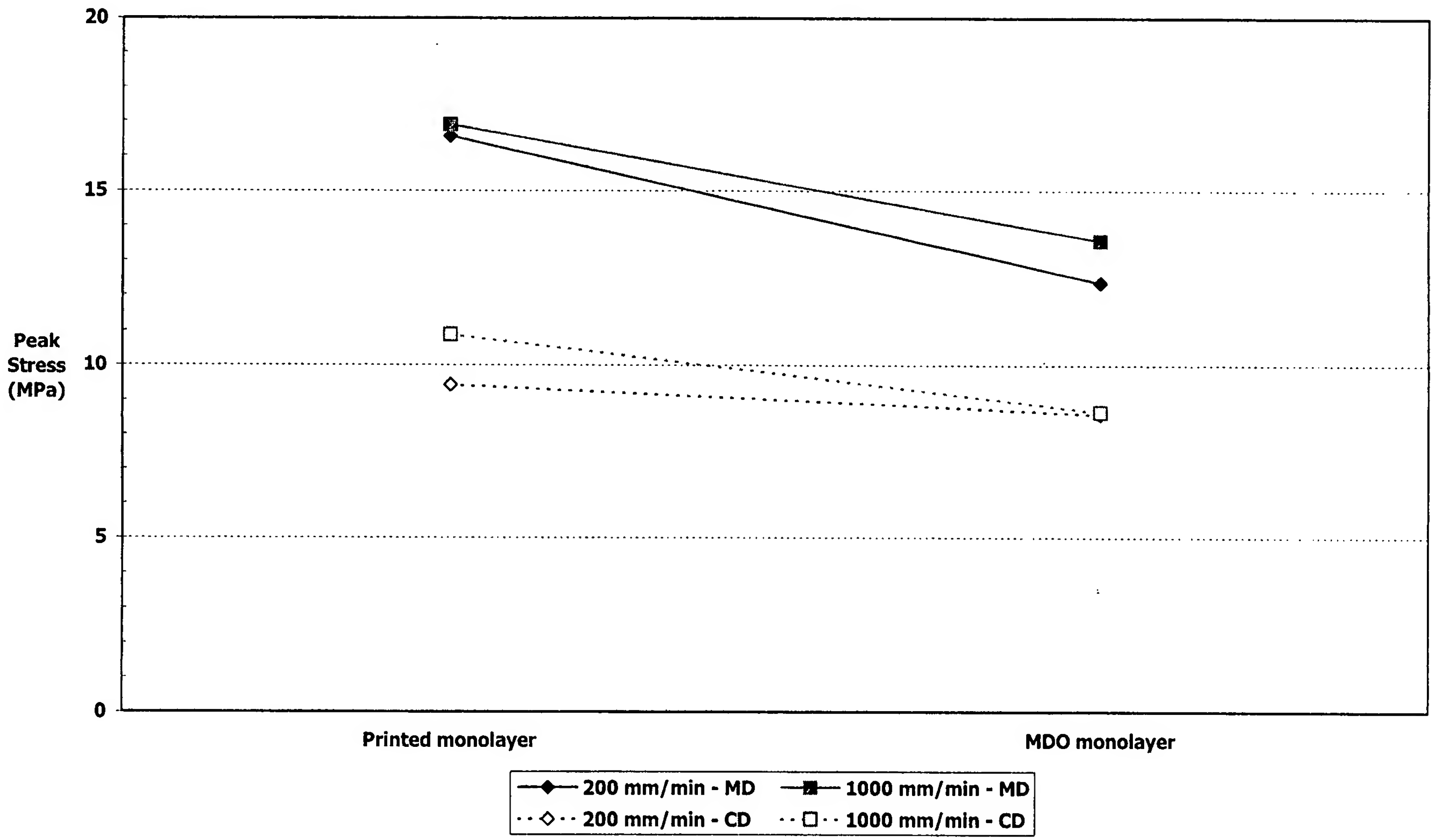


Figure 1. Peak Stress of Wraps as a Function of Strain Rate

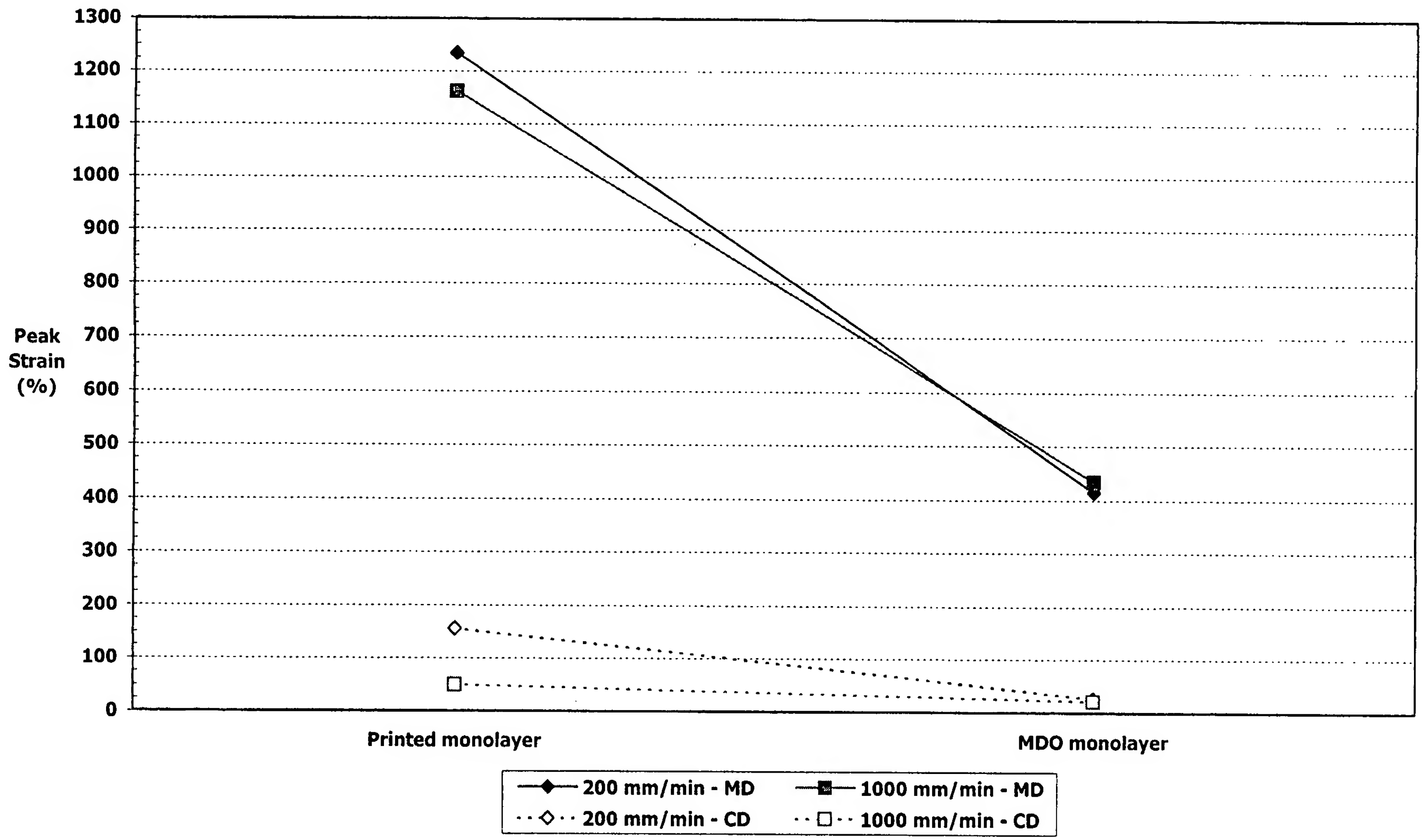


Figure 2. Peak Strain of Wraps as a Function of Strain Rate

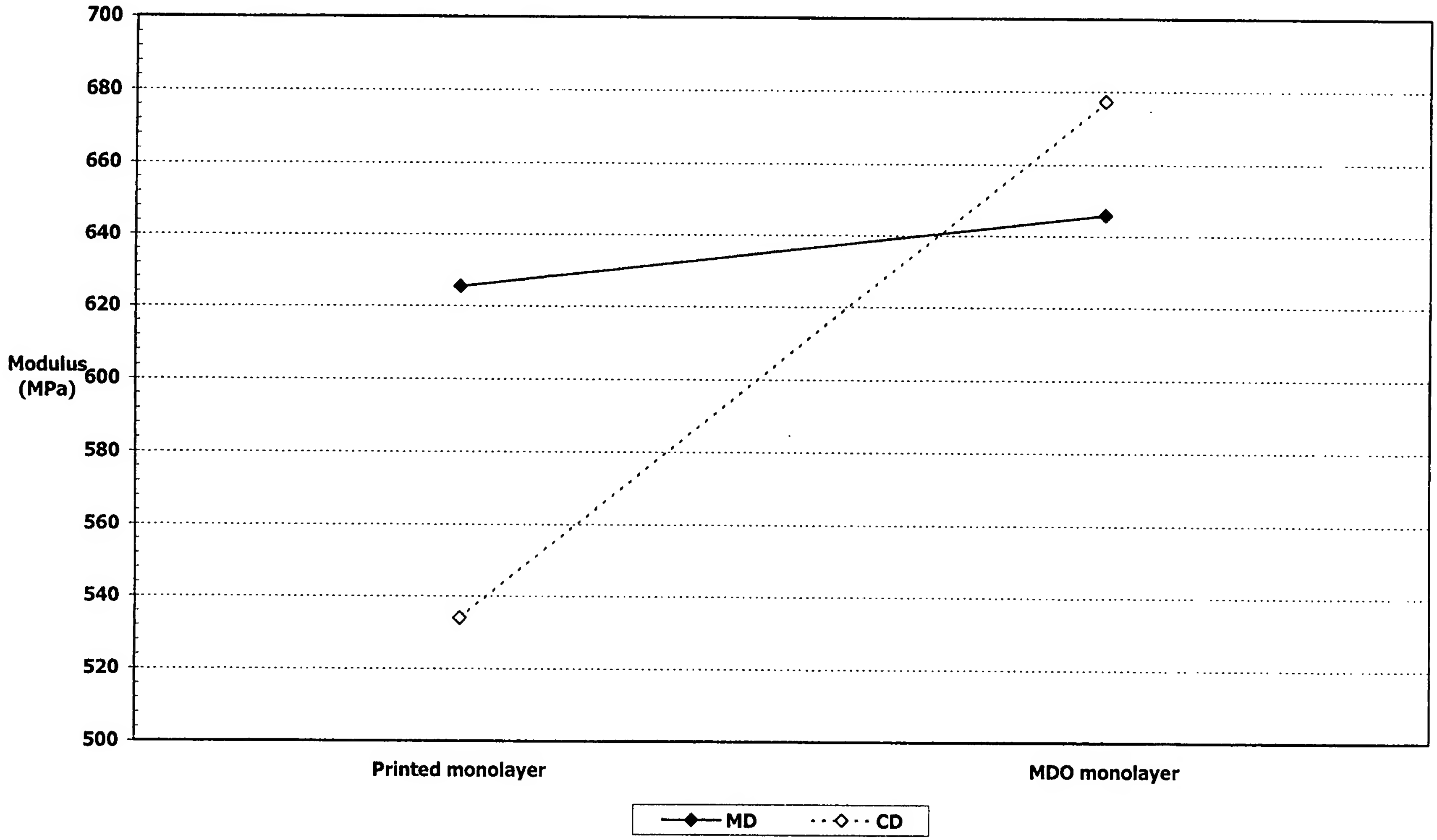


Figure 3. Modulus of Wraps as a Function of Testing Direction

EarthShell CORPORATION

Monolayer MDO Wrap Film

Processing Guidelines

Materials:

DuPont:	Biomax 4026 resin containing 0.20% silica.
Eastman:	Eastar Bio GP resin.
A. Schulman Inc.:	T4338-ES masterbatch using the Eastar Bio GP resin and $CaCO_3$ and TiO_2

Wrap Composition:

The monolayer MDO wrap consists of extruding cast-MDO film from a blend of 50% T4338-ES masterbatch and 50% Biomax resin. This blend gives a final composition of 50% Biomax, 35% fillers, and 15% Eastar Bio in the finished product.

Drying:

The Eastar Bio resin and the T4338-ES Masterbatch should be dried at 150°F for 4-6 hours to -40°F dew-point or 80 ppm resin moisture level and store in sealed foil lined bags. The Biomax resin should be dried at 200°F for 10 hours to -40°F dew-point or 50 ppm resin moisture level and store in sealed foil lined bags.

Equipment:

Avery Dennison cast film line (E-1/2):

This is a four layer line consisting of four extruders, with one 2.5" diameter main extruder, and three 1.5" diameter side-extruders. It is also equipped with an AB Cloeren feed block, and a 24" width die and a matte finished chill roll. It is further equipped with a machine direction orienter (MDO) in the downstream. The line is also equipped with an automatic continuous gage control unit.

For this Monolayer MDO wrap film, use only the 2.5" main extruder.

Suggested line profile for the production of Monolayer MDO Wrap film:

The extruder and downstream processing profile for the production of wrap films from the above mix design is noted below:

Barrel Zones:	1	2	3	4	5	6	7	8	9	10
Set °F:	400	410	410	410	380	390	390	370	380	380

EarthShell CORPORATION

Die Heat:

Zones:	1	2	3	4	5	6	7	8	9	10	11
Set °F:	410	410	410	410	410	410	410	410	410	410	410

Extruder pressure: 1200 psi

MDO Rolls:

	Pre-heat Rolls	Post-heat Rolls
Set temperature °F	192/165	173/175

MDO ratio: 1 : 2.6 x

Film Gage:

The target gage for Monolayer MDO wrap is between 1.1 – 2.3 mils (pre-MDO gage of 3 – 6 mils; e.g. 4.7 mils film was MDO to ~1.8 mil gage).

EarthShell CORPORATION

Product Specification

Title: **Competitive Wrap: Taco Bell Chalupa Quilted Paper**

Basis Weight: By Layers – (outside) 15 lbs/ream MG paper (±5%)
(middle) 5 lb polyethylene (±5%)
(inside) 10.75 lbs/ream paper (±5%)

Sheet Caliper: Total sheet claiper: 0.95 mil target (±5%)

Brightness, TAPPI T-452 (%): 83 Minimum

Opacity, TAPPI T-425 (%): 70 Minimum

WVTR @ 73F & 50% RH, ASTM F1249 (gm/100 in^2 * 24 hr)
0.40-0.49

Tensile, Wet, TAPPI T-456 (lb/in):

MD	2.14-10.87
CMD	1.06-7.3

Tear, Elemendorf, TAPPI T-414 (gm):

MD	17.2-38.4
CD	19.2-44.0

Coefficient of Friction @73F & 50% RH, TAPPI T-549:

Static	0.34-0.48
Kinetic	0.33-0.47

Dimensions: 12" x 12" square ± 1/8"

Packing: 2,500 wraps per case

EarthShell CORPORATION

Product Specification

Title: **Wrap – A (Papermatch) – 'EarthShell' Print**

Basis Weight:	**12"x12"**	7.37 lbs / 1000 sq. ft, or 3.35 grams / wrap (± 10%)
	10.5"x13"	7.37 lbs / 1000 sq. ft, or 3.17 grams / wrap (± 10%)

Sheet Caliper (observed): 1.8 mil (± 10%)

Brightness, TAPPI T-452 (%): 83.2 Minimum

Opacity, TAPPI T-425 (%): 67.4 Minimum

WVTR @ 20C & 50% RH, ASTM F1249 (gm/100 in^2 * 24 hr)
1.45

Tensile, Wet, TAPPI T-456 (lb/in):

MD	1.48
CMD	1.26

Tear, Elemendorf, TAPPI T-414 (gm):

MD	12.84
CD	10.23

Coefficient of Friction @73F & 50% RH, TAPPI T-549:

Static	0.47
Kinetic	0.36

Dimensions: 12" x 12" square ± 1/8"
10.5" x 13" square ± 1/8"

Packing: 2,500 wraps per case

John M. Guynn

From: Randy Smith [rsmith@earthshell.com]
Sent: Saturday, September 17, 2005 6:05 PM
To: John M. Guynn
Subject: FW: Update Wrap Model
Attachments: Wrap Model - Rev 007 101501 - SIMPLE.xls

Here are the wrap models.

RAS

From: Matt Loos
Sent: Tuesday, October 16, 2001 9:45 AM
To: Donna Balinkie; Randy Smith; Kishan Khemani
Cc: Scott Houston; Matt Loos
Subject: Update Wrap Model

Folks,

Senior management has requested that we simplify the wrap model with respect to assumption input, and flexibility of use. There have been several iterations to achieve this goal. The attached wrap model addresses those issues as well as other improvment requests. If I ignored or misapplied any suggestions or requirements, or some additional requirements have surfaced since we last spoke, please contact me immediately.

Wrap Weight
The wrap costing model is based upon the wrap's weight.
1) For some examples, the weight and dimension are given, and drive the thickness. In this case, we are zeroing in on the thickness for improved economics. We know the desired weight, but what is the required thickness?
2) In the more common case, thickness and dimension are given, and we calculate the weight. We know the desired dimension, but what is the weight?

Given these two scenarios, the model has been improved to easily switch from one case to the other, depending on what is known. The model as distributed today has thickness and dimension as givens and the weight is calculated. If the weight and dimension are known and you require calculating the thickness, you need to type in 'Yes' into cell C19. This triggers the cost model (specifically cell L17) to look at cell C23. Please let me know if you would like training on how to use this added feature.

Wrap Density
The wrap consists of several raw materials of varying density. In order to calculate the wrap density properly, we consider the density of each component. The current wrap density calculation properly considers the successive steps of combining the raw materials and the resulting density at each step (First step: combine eastar and filler to create papermatch. Second step: combine papermatch and biomax to create the wrap).

Please contact me with questions is this model is still not as simple and useful as you require.

Matt

EarthShell Corporation
Biodegradable Wrap Model

Distribution 10/16/01:
Donna
Randy
Scott
Kishan

EarthShell Corporation
Biodegradable Wrap Model

Version changes listed by date (most recent at top)

Color Key

Assumptions link/Input	Light Yellow	
Linked to another tab	Turquoise	(Color Scheme just under Turquoise)
Calculated	Lavender	(Color Scheme just to the left of Lavender)
Drives a link to a tab	Light Green	

Version 007 10-15-01 - SIMPLE - Matt Loos

1- Added detail for resin densities in order to calculate final density of the wrap

2- Added yes/no trigger to how gram weight is used by the wrap costing model

3-

4-

5-

6-

7-

8-

Version 007 10-11-01 - SIMPLE - Matt Loos
Version 007 10-10-01 - SIMPLE - Matt Loos
Version 007 10-08-01 - SIMPLE - Matt Loos
Version 007 10-08-01 - Matt Loos
Version 007 09-26-01 - Matt Loos
Version 007 09-18-01 - Matt Loos
Version 007 09-15-01 - Matt Loos
Version 007 09-11-01 - Matt Loos
Version 007 08-16-01 - Matt Loos
Version 006 06-06-01 - Matt Loos
Version 006 04-18-01 - Matt Loos
Version 005 04-05-01 - Matt Loos
Version 004 03-09-01 - Matt Loos
Version 003 02-20-01 - Matt Loos
Version 002 11-27-00 - Matt Loos
Version 001 11-13-00 - Matt Loos
Version 000 11-07-00 - Matt Loos

EarthShell Corporation
Biodegradable Wrap Model

Sandwich Wrap - Biomax/Eastar - Mono-Layer Film
12" x 12"

50% Biomax - 4026, 15% Eastar Bio GP / 35% Filler - T4338ES

Assumptions	Value	Units
Biomax Density	1.35	g/cc
Eastar Bio Density	1.25	g/cc
Filler Density	2.25	g/cc
Wrap Density	1.65	g/cc
Weight variable (yes/no):	NO	
Film Thickness	23.7	microns
Wrap Width	12	inch
Wrap Length	12	inch
Wrap Weight	3.63	grams
Weight calculated:	YES	
Film Thickness	23.7	microns
Wrap Width	12	inch
Wrap Length	12	inch
Wrap Weight	3.63	grams

		Weight Mix ratios Fin.Prod.	mat req'd g/piece		Price/LB $	Cost/1000 $
	Raw Materials:					
	Biomax 4026	50.0%	1.82		1.10	4.41
	Eastar Bio - GP	15.0%	0.54		1.00	1.20
(a) (e)	Filler - Assume CaCO2	31.0% (f)	1.13	(g)	0.09	0.22
	Whitener - TIO2	4.0% (f)	0.15		0.90	0.29
	Total Raw Materials	100.0%	3.63		0.76	6.12
(c)	**Combined converting process**		3.63		0.45	3.60
(b)	Material Loss Allowance during conversion				12.0%	0.83
	Subtotal Raw Mat./Formulation				0.87	10.56
	Secondary Packaging					0.08
	Total Cost of Manufacture					10.64
	Markup	30%				3.19
(d)	**Target Selling Price**					13.83

Notes:
(a) Filler assumed to be compounded into one of the resins by one of the resin manufacturers.
(b) Assumes large quantity runs where the start-up loss is 'amortized' to an effective loss of less than 1%.
Current observations are Casting (12.5%), Printing (3%), and Perforating (1%) vendor observations.
(c) Could be either one of the four following in-line converting processes:
A) Cast Film, MDO, Slit, Print and Perforate on a roll,
B) Cast Film, MDO, Slit, Print and Sheet flat in a box,
C) Blown Film, Slit, Print and Perforate on a roll,
D) Blown Film, Slit, Print and Sheet flat in a box.
(d) FOB converter. Freight to Distribution Center not included.
(e) Targeting \$0.65 to \$0.71 for 'filled' Eastar masterbatch.
(f) Papermatch has 31% $CaCO_2$ and 4% TIO_2.
(g) Current quote for wrap-specific $CaCO_2$ @ 2 micron thickness for \$0.11.
Current quote laminate-specific $CaCO_2$ @ 25 micron thickness for \$0.0195

EarthShell Corporation
Biodegradable Wrap Model

Sandwich Wrap - Biomax/Eastar - Mono-Layer Film
10.5" x 13"

50% Biomax - 4026, 15% Eastar Bio GP / 35% Filler - T4338ES

Assumptions	Value	Units
Biomax Density	1.35	g/cc
Eastar Bio Density	1.25	g/cc
Filler Density	2.25	g/cc
Wrap Density	1.65	g/cc
Weight variable (yes/no):	NO	
Film Thickness	23.7	microns
Wrap Width	12	inch
Wrap Length	12	inch
Wrap Weight	3.63	grams
Weight calculated:	YES	
Film Thickness	23.7	microns
Wrap Width	10.5	inch
Wrap Length	13	inch
Wrap Weight	3.44	grams

		Weight Mix ratios Fin.Prod.	mat req'd g/piece		Price/LB $	Cost/1000 $
	Raw Materials:					
	Biomax 4026	50.0%	1.72		1.10	4.18
	Eastar Bio - GP	15.0%	0.52		1.00	1.14
(a) (e)	Filler - Assume CaCO2	31.0% (f)	1.07	(g)	0.09	0.21
	Whitener - TiO2	4.0% (f)	0.14		0.90	0.27
	Total Raw Materials	100.0%	3.44		0.76	5.80
(c)	**Combined converting process**		3.44		0.45	3.42
(b)	Material Loss Allowance during conversion				12.0%	0.79
	Subtotal Raw Mat./Formulation				0.87	10.01
	Secondary Packaging					0.08
	Total Cost of Manufacture					10.09
	Markup	30%				3.03
(d)	**Target Selling Price**					13.11

Notes:
(a) Filler assumed to be compounded into one of the resins by one of the resin manufacturers.
(b) Assumes large quantity runs where the start-up loss is 'amortized' to an effective loss of less than 1%.
Current observations are Casting (12.5%), Printing (3%), and Perforating (1%) vendor observations.
(c) Could be either one of the four following in-line converting processes:
A) Cast Film, MDO, Slit, Print and Perforate on a roll,
B) Cast Film, MDO, Slit, Print and Sheet flat in a box,
C) Blown Film, Slit, Print and Perforate on a roll,
D) Blown Film, Slit, Print and Sheet flat in a box.
(d) FOB converter. Freight to Distribution Center not included.
(e) Targeting \$0.65 to \$0.71 for 'filled' Eastar masterbatch.
(f) Papermatch has 31% CaCO2 and 4% TiO2.
(g) Current quote for wrap-specific CaCO2 @ 2 micron thickness for \$0.11.
Current quote laminate-specific CaCO2 @ 25 micron thickness for \$0.0195